GENERAL LIBRARY
APR 27 1920
U. OF MICH.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

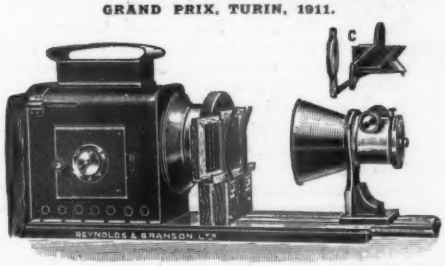
"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 2632, VOL. 105] THURSDAY, APRIL 8, 1920 [PRICE ONE SHILLING

Registered as a Newspaper at the General Post Office.] [All Rights Reserved.

THE
SNOOK X-RAY
Interrupterless Machine
IS THE BEST APPARATUS
FOR RESEARCH WORK
No Inverse Current.
Completely under control.
Conditions can be absolutely reproduced from day to day.
Sole Makers for the United Kingdom—
NEWTON & WRIGHT, Ltd.
72 WIGMORE STREET, W. 1.
Wholesale and Export only.
Obtainable through any Scientific Instrument or Electrical House.

REYNOLDS & BRANSON, Ltd.
THE "RYSTOS" EDUCATIONAL LANTERN.
GRAND PRIX, TURIN, 1911.



With Iron Body (suitable for any illuminant), with side door and brass sight holes, walnut base, meniscus condenser 4¼ in. diameter, objective of superior quality 2½ in. diameter, 6, 8, 9, or 12 in. focus, with rack and pinion. Complete in travelling case.
Price on Application.
CATALOGUES POST FREE.
Optical Lanterns and Lantern Slides; Chemical and Physical Apparatus and Chemicals; British-made Laboratory Ware (including Glass, Porcelain, and Nickel).
14 Commercial Street, Leeds.

DUROGLASS LTD.
14 CROSS STREET, HATTON GARDEN, E.C.
Manufacturers of
Borosilicate Resistance Glassware.
Beakers. Flasks, Etc.
Soft Soda Tubing for Lamp Work.
General Chemical and Scientific Glassware.
Special Glass Apparatus Made to Order.
DUROGLASS WORKS, WALTHAMSTOW.
AGENTS:
BAIRD & TATLOCK (LONDON) LTD.
14 CROSS ST., HATTON GARDEN, E.C. 1.

Deep-Sea Thermometers.
Latest pattern embodying several improvements for accurate work:—
(a) Divided to 1/5° C.
(b) Attached Thermometer.
(c) Volume at 0° C., and expansion of glass, stated.
(d) Increased sensitiveness.
Tested to 3 tons per square inch.
Made to any required range.
Illustrated Price-list of "Deep-Sea Thermometers" forwarded on request.
NEGRETTI & ZAMBRA
38, HOLBORN VIADUCT, E.C.1
Factory:
HALF MOON WORKS, BARNSBURY,
LONDON

NOTICE.

The issue of *NATURE* for Thursday next, April 15, will contain the Index to Vol. 104.

Its price will be Two Shillings.

Office: ST. MARTIN'S STREET, LONDON, W.C. 2.

OLD STUDENTS ASSOCIATION
of the
ROYAL COLLEGE OF SCIENCE, LONDON.

The Ninth Annual Dinner of Old Students will be held at the Café Monico, Piccadilly Circus, on Saturday, 24th April, 1920, at 7 for 7.30 p.m.

The price of tickets will be 10s. 6d.

The Most Hon. the Marquess of Crewe, K.G. (Chairman of the Governing Body), Sir Alfred Keogh (Rector), and other distinguished guests, have signified their intention of being present.

Tickets may be obtained from:—
Mr. CHARLES S. GARLAND,
Acting Secretary, Old Students Association,
Royal College of Science, South Kensington, S.W. 7.

UNIVERSITY OF EDINBURGH.

FACULTY OF MEDICINE.

No one can be accepted for entrance as a Medical Student without a formal application being submitted for the consideration of the Faculty of Medicine.

Applications for admission in the Winter Session, which commences on October 6, 1920, must be in the hands of the DEAN of the Faculty of Medicine not later than Friday, April 30.

Applicants should state their age, particulars of their general education and examinations passed, and, if they have been on war service, full particulars of such service.

WILLIAM WILSON,
Secretary of the University.

THE GROCERS' COMPANY'S SCHOLARSHIPS.

With the object of encouraging original research in Sanitary Science, the Grocers' Company offer TWO SCHOLARSHIPS, each of £300 a year with an allowance to meet the cost of apparatus and other expenses in connection with the work, tenable for one year, but renewable for a second or third year, subject to the conditions of the scheme under which they are established.

The next election will take place in June, 1920.

Applications must be sent in before May 1 to the CLERK of the Grocers' Company, Grocers' Hall, Princes Street, London, E.C. 2, from whom a form of application and further information may be obtained.

HECKMONDWIKE SECONDARY SCHOOL.

WANTED, to commence duties in September, an ASSISTANT MASTER, with good qualifications in Chemistry (Mathematics subsidiary). An Advanced Course in Science and Mathematics is recognised in the School.

Salary begins at from £180 to £300, according to qualifications and experience, and rises to £450.

Applications to be made on forms which can be obtained from the HEADMASTER at the School.

BIRKBECK COLLEGE.

PHYSICS.

There is a vacancy for a STEWARD AND HEAD LABORATORY ATTENDANT in the Physics Department. The rate of pay is £3 10s. a week. Further particulars will be forwarded on receipt of an addressed foolscap envelope. Applications for the post must be received by April 19.

G. F TROUP HORNE,
Secretary.

Birkbeck College, E.C 4.

THE SIR JOHN CASS TECHNICAL INSTITUTE,

JEWRY STREET, ALDGATE, E.C. 3.

Principal—CHARLES A. KEANE, D.Sc., Ph.D., F.I.C.

The following Special Courses of Instruction will be given during the Summer Term, 1920:—

THE THEORY AND APPLICATIONS OF MATHEMATICAL STATISTICS.

By E. C. SNOW, M.A., D.Sc.

A course of 10 lectures, followed by a seminar, on the modern mathematical methods of dealing with statistical data in social, educational, economic, meteorological, and medical problems, suitable to teachers and students of economics and meteorology. Friday evenings, from 7–9 p.m., commencing **Friday, April 23, 1920.**

THE TRANSMISSION OF POWER IN WORKS.

By H. B. RANSOM, M.Inst.C.E., M.Inst.Mech.E.

A course of 10 lectures, arranged for those engaged in Works connected with Chemical, Metallurgical, and the Fermentation Industries. Monday evenings, 7–8 p.m., commencing **Monday, April 19, 1920.**

TECHNICAL GAS ANALYSIS.

By CHARLES A. KEANE, D.Sc., Ph.D., F.I.C.

A course of practical work suited to the requirements of those engaged in chemical and metallurgical industries. There will be 10 meetings of the class, which will be held on Wednesday evenings from 7–10 p.m., commencing **Wednesday, April 21, 1920.**

MINERALOGY.

By W. R. SCHOELLER, Ph.D., A.I.C.

A course of 10 lectures, followed by demonstrations and laboratory work, arranged for students of Metallurgy, Mining, and Chemistry who desire to obtain a general knowledge of the subject. Wednesday evenings, 7–10 p.m., commencing **Wednesday, April 21, 1920.**

THE HEAT TREATMENT OF METALS AND ALLOYS.

By C. O. BANNISTER, A.R.S.M., M.I.M.M., F.I.C.

A course of 6 lectures, accompanied by practical work in the Metallography and Testing Laboratories, arranged for those interested in the after-treatment of manufactured Iron and Steel and the principal Industrial Alloys. Tuesday evenings from 7–10 p.m., commencing **Tuesday, April 27, 1920.**

THURSDAY, APRIL 8, 1920.

The Universities and the Army.

MORE than a year ago—on February 20, 1919—an article on "Education in the Army" was published in these columns in which urgent reasons were advanced for a new policy. During the intervening period, numerous contributions have been made to various newspapers and reviews on the same subject, and book has succeeded book animadverting on the educational defects of the Army organisation as revealed by the war. Great disappointment will be felt that these sincere representations have so far produced no more useful result than the Memorandum on the Army Estimates of 1919-20, recently published by the War Office "in amplification of the speech of the Secretary of State in introducing the Estimates." That speech, delivered by Mr. Churchill on February 23, was able and serious within somewhat exiguous limits, but it contributed nothing to the question of educational reform in its military aspects. We are forced, therefore, to turn to the amplifying Memorandum in the anxious hope of finding the question discussed on broad lines and in a scientific spirit. It proves to be a Mother Hubbard cupboard containing only a schoolboy essay freely embellished with mixed metaphors. Thus:

"One of the important lessons of the war has been the extent to which the Army is dependent on the Universities. Great strides were made in this direction before the war, with the result that the Universities responded to the call for help in a splendid manner."

This belated recognition of the valuable work of the Universities in connection with the war is well and fair so far as it goes, but it affords no guarantee to the British public, whose ears are still attuned to the sad diapason of the war's tragedies, that the reorganisation of the Army on its educational side is to be taken seriously in hand. The fact that the Secretary of State, in his speech, found the subject unworthy of even a passing reference is surely disconcerting.

We pointed out recently that the Memorandum deserves to be commended for the proof it affords of the recognition by the Army of the importance of scientific research conducted both under its direct supervision and in our Universities and colleges. Every science and every scientific worker can make some contribution to national defence.

To give Mr. Churchill his due, he appears to realise the economy of men and money which may result from new applications of science. He quoted in his speech, as an example of the possibilities of the Air Force, the case of the recent Somaliland campaign, which, at a cost of 30,000*l.*, achieved much more than an expedition before the war which cost 2,500,000*l.*; and he described a new form of tank, which, so far from damaging the roads, actually improved them, and possessed an engine which, instead of overheating the interior, exercised a refrigerating effect. But what we ask, and what we shall insist on knowing, is whether this new spirit is to permeate the whole Army, or whether, when the wounds of war are healed and its bitter memories pass into subconsciousness, the Army will revert to its old traditions.

Fortunately for the Army and for the nation, one of the root causes by which these traditions were fed has been effectively removed. Before the war, officers were not paid a living wage, and that system was deliberately perpetuated in order to maintain the tradition of the officer as a gentleman of means and leisure who did half a day's work for half a day's pay. As a writer in the *New Statesman* observed (January 25, 1919):

"It is no use pretending now that the system gave us an efficient Army. One does not gather grapes from thorns. The ablest boys in the country's schools went almost invariably into other callings. Some few officers, with the German menace before their eyes, did indeed work with most praiseworthy, unpaid energy in the years immediately preceding the war. But no gratitude to the 'Old Contemptibles' should blind us to the fact that, however devoted their officers were, they were clearly outclassed as professional men, both by their German opponents and by their French Allies; and that in spite of the unique opportunities afforded by Colonial and Indian war experience."

Under the revised rates of pay of Army officers, a junior subaltern receives pay and allowances amounting to 320*l.* a year if unmarried, or 394*l.* if married, and is able to look forward to generous increments on promotion and to an adequate pension. It will be a breach of trust if, under these conditions, the Army Council does not propose far-reaching reforms as regards standards of education and training for the commissioned ranks.

There is no reason why a standard of professional training at least equal to that required by other professions, such as medicine and engineering, should not be required by the Army, and the only imaginable obstacle to this reform are the protests of old Regular officers, who think that the system which produced them must be the best possible. That particular obstacle has been overcome more than once in the history of the British Army, and it should not deter Mr. Churchill if he will devote to this reform some of the energy which he expends so generously on more forlorn objects.

To pass from destructive to constructive criticism, we would urge that the standard of education represented by three years' study at a University should, as a general rule, be demanded of all Army officers; in other words, that the raw material for the commissioned ranks should be University graduates rather than public-school boys. The military colleges at Woolwich and Sandhurst should no longer be used as seminaries for the elementary education of adolescents.

A great economy of public money would be effected by this simple reform. According to the Estimates for 1919–20, Sandhurst for 700 cadets will cost a gross amount of 195,350*l.*, being 279*l.* 1*s.* 5*d.* per cadet per annum, while Woolwich for 280 cadets will cost 86,850*l.*, or 310*l.* 3*s.* 7*d.* per cadet per annum. It is "pure" education which these young men chiefly require; they should obtain it in the Universities, which can offer a wide variety of curriculum and abundant facilities for social intercourse with all types of student. The University contingents of the Officers Training Corps are admirably adapted for providing elementary military training, which could be supplemented within the Army before and after the student takes his commission. Incidentally, the Army would be able to select for its commissioned ranks mature men possessing a livelier sense of vocation than can be expected from schoolboys.

If the quality of the raw material were improved in the way suggested, there should be no ground for nervousness as to the finished product. Methods could easily be devised of advancing and specialising the military training of these young University graduates. In time a *corps d'élite* would be formed able to study the art of war in all its aspects and to apply new scientific ideas and discoveries to national defence.

Woods and Water Supply.

Forests, Woods, and Trees in Relation to Hygiene. By Prof. Augustine Henry. (The Chadwick Library.) Pp. xii+314. (London: Constable and Co., Ltd., 1919.) Price 18*s.* net.

PROF. HENRY writes of forests, woods, and trees with an enthusiastic appreciation of the beneficent part they play in the economy of Nature and in the service of man. He has devoted great energy to the study of his subject, and collected data of much value which will prove very useful to those engaged in projects of afforestation in this country. The importance of the subject is, we believe, fully realised by the Government, and Prof. Henry adduces so many instances of local authorities which have begun to move in the matter that we may hope to see the restoration of the woods on waste lands making steady progress year by year.

The book before us is an amplification of the Chadwick Lectures delivered by Prof. Henry at the Royal Society of Arts in 1917, and the author no doubt looks upon it in large measure as propaganda in the cause of tree-planting on a national scale. The first three chapters, however, deal with matters of profound scientific importance—the influence of forests on climate, the sanitary influence of forests, and forests as sites for sanatoria. These are difficult matters, as Prof. Henry fully realises, and some of them have agitated students of physical geography for generations. The difficulty of the question of the influence of forests on climate arises in great measure from the fact that climate has a great influence on forests, so that in wooded areas the interplay of cause and effect becomes extremely complicated.

Prof. Henry has read up the subject widely, but the nature of his book makes it impossible for him to focus the results sharply enough. He abundantly justifies the thesis that an increase of forest growth is of national importance for improving the hygiene and the economic condition of this country; but he scarcely attempts a scientific demonstration of the mechanism by which the beneficial effects are produced. He does, indeed, direct the attention of his readers to many recent investigations which it is most useful to have brought together, and for this guidance the student who wishes to go farther should be sincerely grateful.

We cannot, however, accept the results of some of the series of observations referred to without a more critical discussion of the methods employed and the data recorded in different parts of the world. In particular we agree with Prof. Henry in his opinion that the effect of afforestation in

increasing the general rainfall is probably negligible in the British Isles.

The greater part of the volume is devoted to a question of national importance—the afforestation of water-catchment areas, with particulars of the extent to which the work has already proceeded. This is timely, for the whole question of the water resources of the country is now under investigation by a Committee appointed by the President of the Board of Trade and the Minister of Health. Prof. Henry shows clearly that the gathering grounds for the reservoirs of water supply by gravitation are well fitted in almost every case for planting with timber-trees up to an elevation of 1000 ft., and he adduces some evidence to show that covering a certain proportion of the surface with forest growth, so far from being detrimental to the yield of the areas, is even helpful. Curiously enough, he does not refer to the important influence of high vegetation, and especially of trees, in precipitating moisture from mist, a phenomenon which is shown very strikingly when one is traversing a road through a wood in a thick mist. The road remains perfectly dry, while the drip of water from the branches on either side gives out the sound of abundance of rain, and the ground beneath the trees soon becomes saturated. As Dr. Marloth proved on Table Mountain many years ago, even such inconspicuous growths as a bed of reeds can draw liquid streams from a cloud drifting along mountain slopes which would deposit nothing on a bare stretch of soil or rock. No doubt a certain amount of water is in this way added to a forest-covered catchment area without being recorded in properly exposed rain-gauges.

On the other hand, if, as certain experiments made in Germany and quoted on p. 3 seem to suggest, the transpiration of forest trees is greater than the evaporation from an exposed water surface, the net result may be to reduce the amount of water reaching a reservoir, and this might be a serious matter in a dry summer. Even if we admit that afforestation does not appreciably increase the available run-off, it seems unlikely that it can seriously diminish it, and the balance of probability is that planting a water-catchment area is beneficial. A wide belt of woodland surrounding a reservoir must reduce the wash of surface material into the streams, and so retard the silting up of the reservoir. But, what is more important, the value of the forests when once established will justify the acquisition of the whole drainage area of their water supply by authorities which could not otherwise justify the expense of such a step; and it is only on ground which is the property of the water authorities that it is possible to keep the area free of population or of farm stock, and so secure the water absolutely from all sources of pollution.

This is scarcely the place to criticise the list of catchment areas for water supply in the United Kingdom, which fills 135 pages, and appears to be based on official figures; but one cannot help regretting that the data quoted are not more homogeneous. Rainfall figures, for instance, are given only in some cases, and even then they are often misleading from the lack of information as to how the average was computed. The responsibility for this is on the local authorities themselves, and we can only thank Prof. Henry for his diligence in bringing so many facts together that the room for improvement in the form of statement stares one in the face. No remedy for these ill-assorted statistics can be found until some central water authority comes into existence which can co-ordinate all the local efforts in accordance with one national and scientific system. One slip, however, should be corrected—the allocation of Haweswater to the supply of Penrith on p. 175 and on the map on p. 173. This should be Hayeswater, a small tarn lying between Haweswater and Ullswater.

HUGH ROBERT MILL.

The Wilds of South America.

(1) *In the Wilds of South America: Six Years of Exploration in Colombia, Venezuela, British Guiana, Peru, Bolivia, Argentina, Paraguay, and Brazil.* By Leo E. Miller. Pp. xiv+428. (London: T. Fisher Unwin, Ltd., 1919.) Price 21*s.* net.

(2) *University of Pennsylvania. The University Museum Anthropological Publications.* Vol. ix., *The Central Arawaks.* By William Curtis Farabee. Pp. 288+xxxvi plates. (Philadelphia: The University Museum, 1918.)

(1) MR. MILLER'S well-illustrated book is the attractively written personal narrative of seven exploring expeditions to South America, all but one sent out by the American Museum of Natural History, mainly to collect mammals and birds.

There are few wild countries left which have not been ransacked with the hope that the amassed specimens may include some species "new to science," but there are still fewer the fauna and flora of which have been correlated intelligently with scientific observation of the prevailing environmental conditions. Several American museums stand in the front rank of such

enterprises, well planned, with, perhaps, restricted but intense purpose. Mr. Miller, of the American Museum of Natural History, was a member, or the leader, of these expeditions, which from the spring of 1911 to the beginning of 1916 covered an enormous amount of ground: Colombia, in which faunistic paradise alone he spent nearly two years; Venezuela and British Guiana; Bolivia and Argentina; and Roosevelt's famous journey. It is worth noting that our active author finished this book in an aviation concentration camp preparing to "do his bit."

This narrative contains no tedious itineraries. It is a condensed account of, in the aggregate, five years' travelling, with many hundreds of episodes, observations, and reflections, which cover a very wide field, from old churches to local industries, people and scenery, plants and creatures, just as he happened to come across them. There are no blood-curdling incidents, although he had his fair share of danger. Since we are taken through steaming-hot tropical lowland forests, over rivers by raft, canoe, or steam launch, across desert plateaux on to snow-covered mountains, to wild natives and modern towns, a few bare samples or headings must suffice to indicate the range of the work:

A successful search in the highlands of Colombia for the "Cock-of-the-Rock," of which beautiful bird's home life, nest, and eggs little was known. Humming-birds becoming intoxicated with the sap of some tree tapped by woodpeckers. A study of the different modes of feeding of various birds as observed side by side: the parrots climbing to the tip of the fruit-laden branch; the large-billed toucans are enabled to reach a long distance for the coveted morsel, whilst the trogons, with short neck, delicate feet and bill, hover about the fruit. Whilst one river was muddy and potable, another, close by, had clear red water, unfit for drinking, and it contained only a few kinds of fish, but no crocodiles, sandflies, or mosquitoes were about.

Mr. Miller suggests that monkeys may keep the malaria infection alive in districts which, because of this plague, are practically uninhabited by human beings.

In some parts of Bolivia vampires were so common and so little shy that the author was able not only to watch their biting and sucking, but also to sweep them off the mule with a butterfly-net—a feat which frightened the suffering beast so much that it sank to the ground with a groan.

The Sirionó tribe in the same country use bows so powerful that the hunter has to lie down, to grasp it with the feet, and to draw the cord with both hands. They are fierce savages, not "Indios reducidos"—*i.e.* not yet broken and cowed—and no wonder. They had fixed some *protégés* of a mission station to trees by means of numerous long thorns. The padre in turn had seven captives tied to posts, and after four of them had died from starvation and sullenness, the priest took pity upon the remaining three and released them.

As usual, the Indian's mind is rather perplexing. A woman asked the exorbitant price of 4 pesos for a fowl, which she said was a first-class game-cock; when told that the bird was wanted for food only, she at once parted with it for 60 centavos.

On a sandstone plateau, at an elevation of 13,400 ft., was growing the gigantic "Puya," one of the Bromelia family, and humming-birds (*Patagona gigas*) hovered over its numerous flowers.

Monstrous lies grow sometimes from a grain of truth, and so do colossal horned snakes in Brazil. Their size at least is proved by a cunning mixture of circumstantial evidence and further reflection: for instance, the discovery by trustworthy hunters that the so-called horned snakes are really not horned creatures, but such as have swallowed an ox tail foremost, the spreading horns ultimately lodging crosswise in the corners of the mouth—quite a sufficient explanation in countries where anacondas are said to grow to 40 metres in length. But there are also very many observations and valuable reflections by the author himself, frequently concerning the supposed working of natural selection. For example, if the struggle for existence is as keen as is often thought, how can the female insectivorous bat, encumbered with her baby fully three-quarters as large as herself, compete successfully with the unhampered males?

There is also an important account of the cow-bird's (Molothrus) parasitic habits, compared with which those of our own cuckoo seem insignificant, dozens of eggs being dropped into a single nest of the Owen-bird (Furnarius), so that the latter deserts it.—That human curse of the tropics, the plume-hunters, in Paraguay and elsewhere, now scatter poisoned fish over the egret's feeding-grounds during the breeding season.

(2) Mr. Farabee's work on the Arawaks is one of the volumes containing the results of an expedition, from 1913–16, sent to South America by the Museum of the University of Pennsylvania. It deals in detail with the Arawak tribes, their somatic characters, mode of life, traditions and beliefs, ornaments, weapons and other implements. One hundred pages are devoted to the language.

The general account is most interesting reading, but the book is really intended for the specialist.

There are, however, no fewer than thirty-six plates of excellent photographs, notably those which represent the people and their mode of life. The greater number of Arawaks inhabit the savannahs of southern British Guiana and the neighbouring parts of Brazil. The largest of the tribes is that of the Wapisianas, and they number only about 1200. Others amount to fewer than one hundred each, all rapidly decreasing.

Mr. Melville, magistrate and protector of Indians, has lived amongst them for twenty-five years, guarding them from the unscrupulous exploiter. "No traders or missionaries have yet established themselves amongst them, hence their natural honesty, their simple purity, and their primitive religious ideas have not been destroyed."

The author says that the coincidence between our classical and the Wapisiana interpretation of the zodiacal and other constellations is not to be wondered at. To call Orion the warrior is obvious enough. But the Pleiades are "the turtle's nest full of eggs and father of the rains," the beginning of the June wet season. Spica is the corn-planter; Scorpio, the anaconda; and Antares, the scorpion's heart, a red macaw swallowed by the snake. α Cygni is the kingfisher. α and β Centauri are a hunter with his wife.

Life and Temperature.

Action de la Chaleur et du Froid sur l'Activité des Etres Vivants. By Georges Matisse. Pp. ii + 556. (Paris: Emile Larose, 1919.)

M. G. MATISSE has brought together in book form researches made by him on the influence of cold and heat on living organisms. He reminds us of the famous experiments of the Abbé Spallanzani, prince of biologists, who showed that dry rotifers could be submitted to temperatures far below zero and up to 62·5° C., and yet return to active life on wetting. Pouchet tells of the strange views which were mooted concerning the death and resurrection of these animals and others experimented upon by Spallanzani, and how Fontana, for fear of the Inquisition, experimented in secrecy, while the Abbé fearlessly published his results and speculations. Spallanzani crushed frozen eggs of insects with the finger-nail and found that small drops of liquid exuded. Life is preserved in this fluid, a "superfusion" of the colloids and electrolytes of protoplasm, the water freezing out. He found seventeen was the greatest number of freezings and thawings which any rotifers, Tardigrades, or Anguillula withstood. Gradual thawing is essential for the preservation of life. Pictet successfully froze and thawed frogs and fish. Spallanzani was the first to sterilise infusions by heat.

M. Matisse recalls Ehrenberg's observations on oscillaria, infusoria, and rotifers living in hot springs in Ischia at 81–85° C.; life in similar conditions, he says, is found in the Yellowstone Park, Wyoming, U.S.A.

We now know that spores of bacteria withstand 100° C. more than sixteen hours, 115° C. from thirty to sixty minutes, and 140° C. one minute. Not only does temperature count, but also time. Claude Bernard found that pigeons and guinea-pigs died in six minutes when put in a dry oven at 90–100° C., rabbits in nine minutes, and dogs in eighteen to thirty minutes. A woman stayed twelve minutes in an oven at 132° C. without being strongly incommoded. Pouchet mentions a man who, at the old Cremorne gardens, walked through a perforated metal tunnel which was surrounded with burning brushwood.

Adaptation to temperature is of considerable interest. Paul Bert found that fish, raised quickly from 12° to 28° C., died, but that, raised slowly 2° C. a day, they survived up to 33° C. Tadpoles, kept a month at 15° C., died at 40·3° C.; others, kept at 25° C., died at 43·5° C. (Davenport and Castle). Snails survive exposure to −110° to −120° C. for weeks. Spallanzani showed that their respiratory exchange and circulation cease entirely in the cold. Protozoa survive −200° C.; bacteria, −250° C. for ten hours (MacFadyean).

Seasonal polymorphism depending on temperature is of interest—*e.g.* aphis is wingless, and reproduces parthenogenetically in the summer; it becomes winged, and male and female in form, with sexual reproduction, in the autumn. Papilio *Vanessa porosa—levana* has spring and summer forms. Salamanders, on the high Alps, are small and black, and have only two young, which are born without branchiæ; those on the plains are large, blotched with yellow, and have many young born with branchiæ. Inversion of the climatic conditions reverses the characteristics of these two forms (Kammerer). Tower submitted Coleoptera (*Leptinotarsa decemlineata*) at the time of formation and maturation of sex elements to 35° C. and dry conditions. The eggs hatched in normal conditions showed eighty-four mutations in the ninety-eight individuals which reached adult age.

A gasteropod, *Lymnea stagnalis*, reproduces its kind in water cooler than 12° C., but the progeny are small. In water at 15–18° C. the progeny are larger. The character of smallness becomes fixed; small individuals transported from cold to warmer water continue to have small progeny (Semper).

The main part of Matisse's book deals with the consideration of the law of van't Hoff and

Arrhenius concerning the acceleration by temperature of the velocity of chemical reactions, and the relation of this law to biological functions. The author has carried out a large amount of experimental work and correlated it with that of others.

There is an increase, an optimum, and a decrease of many biological functions with temperature, and in several cases the increase over a certain range is comparable with that of a chemical reaction—*e.g.* the segmentation of an ovum, the beat of the heart, or ferment action. The reactions of the living animal are, however, too complicated to come under any simple law.

A University Course in Botany.

Botanical Memoirs. No. 4: *Elementary Notes on Structural Botany.* By A. H. Church. Pp. 27. No. 5: *Elementary Notes on the Reproduction of Angiosperms.* By A. H. Church. Pp. 24. (London: Oxford University Press, 1919.) Price 2*s.* net each.

CONSIDERABLE interest has been shown during the past two years in the reconstruction of botanical teaching at the universities, and it seems opportune, therefore, that one of the older universities should publish in some detail the plan on which its instruction in botany is based in so far as it relates to the elementary courses in this subject. We gather from the concluding note of Memoir 4 that the notes have been written as schedules to accompany, and not to replace, lectures, it being assumed that the lecturer can add explanatory emendations and enlargements on special points. No doubt every teacher will have his own views as to the arrangement of the subject-matter of an elementary course, and will desire to give special emphasis to certain aspects, which he will do by the prominence assigned to such parts of the subject. A somewhat general feeling has been expressed in the recent correspondence on botanical teaching in the pages of the *New Phytologist* that physiological botany has not always received adequate attention or treatment in botanical teaching.

From that point of view it will be noted with interest that the Oxford course of instruction begins and ends in biological features, and is well permeated with physiological considerations. On the whole, however, it may be considered a morphological treatment of the subject, as, indeed, the title "Structural Botany" indicates, though it is apparent that, as in most elementary courses, structure is considered in the light of the functions which the various organs have to perform. Occasionally this mode of treatment might be more closely adhered to. On p. 6, for instance, in dealing with the stem of Helianthus, it is mentioned that the endodermis is "in this stem curiously the only layer with starch," and no reason for this phenomenon is advanced or even suggested at this stage, though much later in the course (p. 24) "falling starch" is referred to as popular since 1900 as hypothesis of statocyte nature.

In connection with the palisade mesophyll no allusion is made to the function of this tissue, nor are any special reasons adduced for the shape and arrangement of its cells. The same criticism applies to the paragraph dealing with the spongy mesophyll. The main criticism, however, which anyone familiar with the difficulties of instructing students within a severely limited time will level against the course is that it attempts too much within the period indicated by the author as available. Considerably shortened, the course might gain in thoroughness of treatment what it would lose in extensiveness. Interesting and enlightening, for example, as are the leaves of Ficus and Nymphæa, the structure and function of a leaf may be learnt from the cherry laurel alone. Similarly in Memoir 5, some of the seeds mentioned, like those of Aucuba, Æsculus, Juglans, and Hedera, are not essential to the proper understanding of the structure of a seed in addition to the two or three more common types. These are only a few of many passages which might be curtailed. No doubt the better plan would be to retain the fuller course and to demand a longer period for instruction, and we heartily sympathise with the author's difficulties when required to supply what he calls "minimum botany" for his students. Possibly under the new *régime* at Oxford this may be remedied. If the facts are as stated in the concluding paragraph of Memoir 5, it is, as the author says, remarkable that in a university of primary importance the teaching of plant biology should be of such a meagre description. We fully share the author's conviction that a knowledge of life in some form should be part of the mental equipment of every educated person.

Recent Mathematical Text-books.

(1) *Unified Mathematics.* By Prof. L. C. Karpinski, Prof. Harry Y. Benedict, and Prof. John W. Calhoun. Pp. viii + 522. (Boston, New York, and Chicago: D. C. Heath and Co.; London: George G. Harrap and Co., Ltd., 1918.) Price 10*s.* 6*d.* net.

(2) *Elementary Calculus.* By C. H. P. Mayo. (With answers.) Pp. xx+345+xxxix. (London: Rivingtons, 1919.) Price 10*s.*

(3) *Mensuration for Marine and Mechanical Engineers. (Second and First Class Board of Trade Examinations.)* By John W. Angles. Pp. xxvii+162. (London: Longmans, Green, and Co., 1919.) Price 5*s.* net.

(4) *School Mechanics. Part* 1. *School Statics.* By W. G. Borchardt. (Without answers.) Pp. viii+266. (London: Rivingtons, 1919.) Price 6*s.*

(1) THIS text-book by three American authors is best described as an elementary mathematical *mélange*. It ranges over a variety of topics, but does not deal explicitly with the calculus, though the fundamental process of the latter is used. Great pains have obviously been expended on the compilation, but it can scarcely be described as an inspiring volume, and is not likely to find favour in British schools and colleges. The authors state in the preface that they desire to emphasise the fact that mathematics cannot be artificially divided into compartments with separate labels, and that they aim at showing the essential unity, harmony, and interplay between the two great fields into which mathematics may properly be divided—namely, analysis and geometry. It is to be feared that those who are to become competent mathematicians must continue to study the subject in compartments, carrying on, of course, several sections simultaneously, leaving familiarity and time to show the inter-relationship. None but the finished scholar can fully appreciate and realise the intertwining of the branches. Only those who reach the hill-tops see the harmony of the landscape and the trend of the watercourses. There are several interesting diagrams and historical references, and also a number of good examples. The volume is well got up and printed.

(2) Mr. Mayo's well-printed and finished book is meant for beginners, for general use in schools, to be within the capacity of the average boy, and also to meet the first requirements of those who intend to specialise in mathematics. That the book will realise all these aspirations is unlikely. So early as p. 6 it presents the beginner with the expression $\lim_{x \to 1} \frac{x^2-1}{x-1} = 2$, and discusses arithmetical approximations and negligible quantities. The introduction to the subject is of that kind which always leaves the student with the uneasy feeling that the calculus is not quite all right, and gives results just a little out. It is the belief and experience of the reviewer that the opening pedagogics of the calculus must be simple and not over-refined. The easy processes of finding the gradients of chords of curves of the system $y=x^n$ and of deducing therefrom the gradients of the tangents are about all that the average boy can grapple with for a considerable time. The notation can be explained concurrently, and a few easy steps lead on to simple integration and easy applications. Geometry and intuition must be relied on to give the start. The philosophy of the limit is beyond the ordinary pupil. From the school point of view the book covers a fairly wide range, including triple integrals, singular points, partial differentiation, and differential equations. There are many good examples in it, derived from geometry, physics, mechanics, etc., all likely to stimulate a smart boy. In fact, it will probably succeed much better as a second than as a first course.

(3) This is a book on mensuration intended for the use of engineering students of various kinds, as, for example, marine engineers preparing for the First and Second Class Board of Trade Examinations and for the Extra First Class Examination. It deals in a thorough way with the ordinary elementary areas and volumes, such as those of the rectangle, circle, ellipse, sphere, cone, and cuboid, refers to the planimeter, explains Simpson's Rule, and discusses valves, specific gravity, flow of water, etc. It includes also some calculus and the theorems of Pappus. There is an abundance of good examples in the book, both worked and to be worked, so that any student who goes through it conscientiously should conclude his examinations successfully.

(4) Mr. Borchardt's book is part 1 of a School Mechanics, and deals with statics. It is intended for the use of pupils preparing for the higher mathematics, for entrance to Woolwich and Sandhurst, and for the Senior Cambridge Local Examination. The matter is arranged under the following heads, according to the sequence given: the lever, the parallelogram of forces, friction, work and machines, centres of gravity, couples, and general equilibrium. Then follow laboratory problems and test papers. There are plenty of illustrative examples in the text, and a copious supply for the exercise of the student, mostly of a numerical type. If the treatment of the subject presents no fresh or original features, the book is one which can safely be used. J. M.

Our Bookshelf.

The Romantic Roussillon: In the French Pyrenees. By Isabel Savory. Pp. xii+214+xxvi plates by M. Landseer Mackenzie. (London: T. Fisher Unwin, Ltd., 1919). Price 25*s.* net.

THE author of this excellently printed work will not mind our saying at the outset that one of its chief charms is the series of pencil drawings by

M. Landseer Mackenzie. In architecture they give exactly what the trained eye would have us see; in landscape, as in "The Harbour at Callioure," an exquisite sense of atmosphere is conveyed—and, unfortunately, this is the only landscape in the book. The travellers had no high aim in art, history, or geography. They went to this inlet of the eastern Pyrenees because it appeared romantic at a distance. They found it less romantic, but full of charm, the charm that is rarely absent in provincial France. They wandered on foot, and made a spirited ascent of Canigou; but their real interest lay in the old-world villages, the hospitable reception at inns that treat the visitor as a friend, and the general air of remoteness in a land where Catalan is common speech. In history the Roussillon has had no special voice as to whether it should belong to France or Spain. To-day it may well be proud that its lot has lain with France. Was not Marshal Joffre, *le grand-père*, born at Rivesaltes, where the wind blows in across a great lagoon upon the frontier, a relic of the Pliocene sea that once stretched up among the hills? From Roussillon also came Commandant Raynal, the hero of the Fort de Vaux at Verdun, and many a stout defender of the northern lines.

The author, however, is not concerned with such modernities. We gather that her pleasant pilgrimage was made before the war turned all minds to other fields in France; but now the land lies once more open to adventure, and conditions of travel, as we are assured by high authority, are already settling down on their old attractive lines. Naturalists are also artists, and they may well practise their art among the eastern spurs of the Pyrenees. G. A. J. C.

The Journal of the Institute of Metals. Vol. xxii. No. 2. 1919. Edited by G. Shaw Scott. Pp. xii+428+31 plates. (London: The Institute of Metals, 1919.) Price 31*s.* 6*d.* net.

THE new volume of this journal opens with a report of the May lecture delivered by Prof. Soddy dealing with the subject of radio-activity. The remainder consists of the papers read at the Sheffield meeting of the institute. Of these the most discussed was one by Dr. Hatfield and Capt. Thirkell on season-cracking, in which a different view is taken from that recently put forward by Rosenhain and Archbutt, and experiments are made to determine the intensity of the internal stress in the case of cold-worked brass. The conclusion is drawn that such stresses approach very closely to the maximum stress which the material is capable of resisting. The mercury salt method has been found very useful for revealing the presence of internal stress. Some very remarkable alloys are described by Dr. Stead. Alloys of tin, antimony, and arsenic, within certain limits of composition, have the habit of forming spherical segments of striking regularity. Dr. L. J. Spencer gives a summary of the information as to the occurrence of strongly curved crystals in minerals, but no satisfactory explanation has yet been given of the conditions under which such curved growth takes place.

The second report to the Beilby Committee on the solidification of metals describes the isolation of crystal grains from certain metals, and a comparison of their form with that of foam cells, the facts pointing to the importance of the share taken by surface tension in determining the grain boundaries. The remaining papers deal with the early history of electro-plating, the properties of standard silver, and the structure of bearing metal, Britannia metal, nickel silver, and duralumin, and the characteristics of moulding sands for non-ferrous work. C. H. D.

Applied Botany. By G. S. M. Ellis. Pp. viii+248. (London: Hodder and Stoughton, 1919.) Price 4*s.* 6*d.* net.

THIS book is one of a "New Teaching Series" of which the publishers state: "The Series has been written by Teachers possessing valuable practical experience and gifted with the inspiration of the hour's occasion." The "secrets of plant life" are said to be "the substance of this extraordinarily interesting volume." On p. 84 the author informs us that "clover is liable to clover-sickness. Turnips suffer from the finger-and-toe disease. These diseases are caused by bacteria"; and later we learn that Desmids and Conjugate Plants are without chlorophyll. Treating of the enemies of plants, the author writes: "Bacteria turn the living tissue to a slimy and often smelling pulp. The effect is very similar to decay." The problems of potato blight have apparently been solved, for we are told that the hyphæ "penetrate the stem and reach the tubers," and "during the winter resting spores of the fungus remain in the ground and attack the next season's crop." Wart disease is a simple matter, infected soil merely being "treated with sulphur and gas lime." Potato-leaf curl is still due to *Macrosporium solani*, and winter rot to *Nectria solani*.

These are but a few of the "secrets of plant life" which are "the substance of this extraordinarily interesting volume." In addition, however, there are many sentences such as the following: "Free-swimming plants, like Chlamydomonas, must have water in which to swim"; and it is with a sorrowful interest that we read: "Very attractive and useful work may be done by studying the development of fruit, and how the seed is in the end successfully disseminated. The student who undertakes this kind of inquiry becomes at last a worthy biologist." The rest of us must learn to bear our cross with resignation.

W. B. BRIERLEY.

Rückläufige Differenzierung und Entwicklung. By Adolf Cohen-Kysper. Pp. 85. (Leipzig: Johann Ambrosius Barth, 1918.) Price 3 marks.

THIS book is a further attempt to reduce all life phenomena to mechanical principles. It announces an "ontogenetic law" worded as follows: "The part returns to a phase from which the whole is developed anew."

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Knowledge and Power.

THE question raised in the leading article on "Knowledge and Power" in NATURE of March 25 is of great interest and importance. It is nothing more nor less than the question of using experience as a guide to action, which is the whole purpose of education. The suggestion that its solution requires a fundamental change in the organisation of the Civil Services in order that the best advantage may be obtained for the country from the special knowledge and training of the expert brings to a focus the essential difficulty of the subject. I suppose that the real function of any Department of the Services, civil or military, is to carry out the policy of the Government as formulated or approved by the responsible Minister; and the staff of the Department is recruited in such a way as to secure that object. The knowledge in the light of which the Minister's policy is formed is another matter. It may be taken for granted that if it is well advised, the Government will utilise all the best technical knowledge available. A Minister may find it in special sections of his own Department, or he may try to acquire it from outside. No doubt he is largely guided by his chief permanent officers, and they in turn must use their own knowledge and that of their subordinates or obtain what they can get from outside. How effectively to provide a Minister with all the pertinent experience about technical problems is not an easy question. It is made still harder by the fact that even for experts the recognition of the value of new knowledge is not necessarily automatic. The reception that was given to Thomas Young's theory of light is a reminder for all time that new ideas require favourable environment for assimilation. Consequently, some knowledge of what the world is made of is necessary for all executive authorities. But that, as Kipling says, is another story.

Suppose we picture to ourselves the difference between a youth's progress in the Civil Service and in the career of an expert in science. The Civil Servant is selected by open competition in subjects which may include literature or science; but from the time of his joining the Service the pursuit of either ceases to be a part of his working life, though either may be followed as a hobby. He must leave even his political opinions at home and begin to learn the art of giving expression to the policy of the Department which he joins. He learns from his immediate superiors how things are done. Why they are done does not concern him. He learns also the discipline of a public office and the art of formulating documents for his superior to sign. His opportunity is to make himself so loyal and so efficient in carrying out the policy that any chance of promotion that comes his way is not lost. If he has lofty ambitions beyond his own steps in the Service, he must postpone them until he reaches a position in which he can gain the Minister's ear. Up to that time his life is a life of self-effacement.

The history of the expert is altogether different. His training leads him to begin his career in research, and if he is successful he attains the unspeakable satisfaction of having discovered for himself something of real importance. Thereafter he has always ideas of his own which he strives to realise, and as his experience grows he forms lines of policy for himself, and is not very tolerant of others. His career is one of continuous self-assertion from the beginning. He may derive his ideas from instruction or inspiration, but the expression of them is his own; and what may be only the natural expression of his genius may look like disloyalty to his superiors in the world of red tape.

The positions of the two types with regard to finance are equally diverse. The Civil Servant has no difficulty in establishing the position that as the Minister wants things done he will, of course, be prepared to provide adequate remuneration for those who carry out his wishes. Money is therefore forthcoming. But the expert has to convince the Minister, or persuade someone else to do so, that his projects are worth trying in the public interest and can be justified in Parliament. He has to ask for permission and facilities for research, the results of which are, *ex hypothesi*, unknown; to ask for pay in addition is to invite refusal of everything.

Moreover, the discipline of a body of experts is quite different from that of a public office. What is wanted from an expert is his own spontaneous opinion as a guide to action—a something which a Civil Servant is not expected to possess. It seems to follow that experts and Civil Servants are as different as oil and vinegar, and the endeavour to mix them promiscuously in one organisation will not work. They belong to different atmospheres; what stifles one gives buoyancy to the other.

Somehow or other an advisory side for formulating policy ought to be organised on different lines from those of the administrative side which carries out the policy. But if there is a separate organisation on the technical side it ought to have direct access to the Minister finally responsible, and not be fenced off from him by a secretariat trained on different lines. There are sure to be misunderstandings and ultimate despair if all the work of a professional technical staff has to pass upwards and downwards through the refracting and distorting medium of an inexpert secretariat. The scheme of organisation must be in sectors reaching continuously from the Ministerial centre to the circle of recruitment. The technical staff itself will want the assistance of "civil servants" content to follow out the policy which is indicated. The mischief begins when the Civil Service forms a complete belt in the inner regions of the organisation. In that case an inexpert Minister is completely surrounded by inexpert advisers, and then power is cut off from knowledge.

F.O.I.

THE vast conflagration of the late war rendered conspicuous many truths that were little suspected by the majority, and not the least of these was the importance, the necessity, of organised and accurate scientific knowledge and research for national success. Unfortunately, this is already in danger of being forgotten while we are engaged in the strenuous task of preserving for our country its due and fitting place in the industries and activities of the world, and the leading article in NATURE of March 25 has sounded a very necessary note of warning. It rightly emphasises the need that the ultimate administrative authority should be vested in men with technical knowledge and experience, and not in Civil Service officials appointed originally, for the most part, on the basis of purely literary attainments. This authority will, however, never be conceded to the man of science until the scale of his remuneration corresponds to the importance of his work. It was repeatedly

demonstrated during the war that scientific men who from motives of patriotism accepted a low scale of salary for their services in Government Departments were accorded an equally modest official status.

The ultimate basis on which an adequate recognition of the importance of the scientific technical expert must rest will be the estimation in which science and scientific research are held by the great mass of intelligent men and women. It must be realised, in the first place, that a training in science on the right lines and under the right men will be as efficient in broadening the outlook on the world and stimulating the imagination of the student as a detailed study of the vicissitudes of ancient wars or the eccentricities of Greek and Latin irregular verbs. It must also be recognised that no course of science can be considered complete unless it has included a session at least spent in scientific research, humble though it may be and directed by more experienced workers. But it must be genuine research, not merely a "heuristic" imitation of the real thing.

The more science graduates who have learnt to understand what research means there are scattered about the country—in factories, in counting-houses, in Government offices, in educational establishments of every kind, and, most important of all, in municipalities and legislative bodies—the wider will be the recognition of the value of science.

Unfortunately, scientific studies are seriously handicapped in the competition for university students by the fact that the fees are, as a rule, distinctly higher than those for arts. There is, therefore, a strong pecuniary inducement for parents to select an arts rather than a science curriculum for their children. Such a handicap is obviously opposed to the national interest, and should not be allowed to continue.

In view of the urgent reasons for associating research with higher scientific education, it is to be regretted that the general tendency of Government policy should be to divorce industrial research from the universities and to place it in the hands of associations of commercial firms. The discoveries that open up new lines of development in great manufacturing industries are arrived at by processes essentially similar to those that lead to advances in pure science, and if we are to get the best results it will be by the co-operation of the vigorous university life which has sprung up in recent years at so many centres in busy industrial districts with the commercial enterprise in its vicinity.

Finally, if we are to secure to science its full weight in the councils and policy of the country, we must not confine our propaganda to the "governing" or upper classes, or to the ranks of professional workers, or to those engaged in commercial pursuits, but we must develop by all the means in our power a love of science in the great army of the manual operatives, whom it would seem that in a not distant future we shall, willingly or unwillingly, have to acknowledge as our masters. With their increased leisure there should be no difficulty in enlisting a large contingent of men and women who will be interested in science, either for its own sake or for its value in enabling them to understand the meaning of the work in which they are engaged. Some of them will in all probability definitely embrace a scientific career, and in this they should receive every assistance and encouragement, while others will render no less service as amateurs and as missionaries of science among their fellows. Already, I am told, a great deal is being done in this direction in connection with University College, Nottingham, and no doubt much is being accomplished on similar lines at the Midland and Northern universities. At present the operations of the Workers' Educational Association are largely confined to the somewhat restricted domains of constitutional law and history and political ecenomy, but a few years may see a great development of more stimulating and attractive studies in the broad realms of science.

March 31. JOHN W. EVANS.

The Secondary Spectrum of Hydrogen.

THE recent investigation by Dr. Merton of the effect of an admixture of helium on the intensity distribution in the hydrogen spectrum appears to have given a very strong clue towards the elucidation of that spectrum. On the photographs taken by Dr. Merton (reproduced in part in Proc. Roy. Soc., October, 1919) the spectra appear completely different in the cases of pure hydrogen and of hydrogen mixed with helium. Many lines, in the first case quite strong, are totally absent in the second; others remain practically unaltered in intensity; while a third set appears in the second case, though practically or completely invisible in the first. Such results seem, at first sight, to point to the existence of at least three classes of lines which are mutually independent, one class being unaffected by helium and the others affected in opposite senses.

A somewhat exhaustive investigation which I have made recently in regard to these photographs, kindly lent to me by Dr. Merton, and the previously published tables of the spectrum has convinced me, however, that this interpretation is not the correct one. It was known already that the secondary spectrum of hydrogen contained two sets of lines, one showing, and the other not showing, the Zeeman effect. A third and doubtful set were abnormal in regard to the Zeeman effect. Dufour examined many of the strong lines in the spectrum, and, although his investigation needs still to be extended much further, a considerable amount of exact knowledge of individual lines is available.

Fulcher also had previously investigated the low-potential discharge in hydrogen, and isolated two band spectra peculiar to this discharge, which spectra we may call the Fulcher bands. They differ from more ordinary bands in their large component separations, and their most important part is in each case a set of triplets which recur towards the red end. Although they do not readily fit the Deslandres type of formula, I have been able to establish a mathematical relationship between the two bands, from which it appears that they must be considered jointly as one band. In addition to the triplets there are many associated sets of single lines, which Fulcher considered, on experimental grounds, to belong to the same band system.

Dr. Merton's results have made a valuable contribution which enables us to isolate these Fulcher bands completely from the rest of the spectrum.

The conclusions at which I have already arrived may be summarised as follows:—

The secondary spectrum of hydrogen consists of a set of band spectra—how far divided into sets which are mutually independent in the mathematical sense is uncertain, but at least partially so divided—together with a superposed spectrum of single lines. The band lines are those which show no Zeeman effect, and the lines of the superposed spectrum all show the Zeeman effect. This general statement still requires considerable experimental work to establish its complete truth, but the evidence so far available is sufficient to leave little doubt in the matter.

Dr. Merton's spectra, taken in the presence of helium, preserve what I have called the superposed

spectrum without much change of intensity, and it is undoubtedly due, on all grounds, to a different atomic or molecular mechanism from that producing the bands. This superposed spectrum exhibits very pronounced "constant frequency difference" effects, and there is good reason to believe that sets of series spectra of the ordinary Rydberg type may be included in it and form the basis of the constant differences of wave-number. The series spectra of hydrogen would then be no longer confined to the Balmer series.

On the photographs the behaviour of the "band" lines is peculiar. The "head"—a word not used in the ordinary sense, but as denoting the strongest line of the band and the one most remote from the red end—is preserved in intensity in helium, or even enhanced, while all the other members disappear. A line in pure hydrogen may be weak, but if it is really a band-head in this sense, it is prominent in the presence of helium—the head is not always the strongest line in a band in pure hydrogen. This consideration is the real clue to the interpretation of the photographs, and it has been found possible to isolate the entire Fulcher band, which is of a remarkable structure and accounts for the great majority of lines between H_α and H_β, in part of which region the previous measures have been very incomplete and misleading. Other strong bands of similar character occur in other regions, and it is already clear that the complete analysis involves only a few such individual bands showing no Zeeman effect, together with a line spectrum showing Zeeman effect, and apparently capable of arrangement in constant frequency differences.

These investigations will shortly be published, but in view of the importance this spectrum has now assumed in relation to atomic structure a preliminary statement of its nature appears to be desirable.

J. W. NICHOLSON.

University of London, King's College,
March 21.

International Council for Fishery Investigations.

A PERUSAL of the programme of the International Council for Fishery Investigations, as outlined in NATURE of March 18, substantiates the criticisms published in 1902 and 1903, as well as later. In the interests of the fisheries and of the public in these critical times it is imperative to direct attention once more to the position. In the original programme of about twenty years ago the Council were to discover whether the yield of the sea-fisheries was increasing or diminishing, and especially to demonstrate the impoverishment of the sea (as if the myriads of ova on the fishmongers' slabs every year afforded no lesson); to show to what extent fishing-grounds could be depleted without danger; to point out what fishing apparatus was destructive; to investigate the small fish grounds; to make discoveries of practical importance to the fisheries; to publish annual results; and finally to produce data (even within two years) on which British and foreign legislation could be based.

Now, after sixteen to twenty years' labour and a great expenditure of public money (for salaries went on during the war), it is found that the impoverishment plea is dropped, along with most of the heads just mentioned as requiring solution. The new scheme, to take the heads in the order in which they appear (see NATURE, March 18, p. 84), includes an inquiry into the result of "the most gigantic scientific experiment ever made in respect to the closure of areas." It is unlikely that the fisheries of the North Sea will be to any extent altered by the partial closure caused through the operations of the Grand Fleet. The ways of Nature are not so simple. Then comes the old phantom of the diminishing plaice and the protection of the race by a size-limit, an impracticable idea so far as the security of the younger plaice goes. The larval, post-larval, and smaller forms are in prodigious numbers, and are safe. Nor is confidence in the Council increased when the ten years' work of the Scottish Fishery Board's ship, *Garland*, in the closed areas is now regarded as ineffective, and the subject not sufficiently studied! In other words, the deliberate conclusions of the Scottish Board, so resolutely upheld, and on which the closure of the Moray Firth and other areas was based, are null and void. That is one way of escaping from an untenable position. The Council may well spare the "intensive study" of the plaice so far as the prosperity of the British fisheries is concerned, and so with further experiments on plaice-marking and drift-bottles, as well as on the food of the young. Nothing important on these heads can result from continued expenditure. The lemon-dab requires little attention, for, like other doomed fishes of the kind, it has re-asserted itself. There is no urgent need for studies on the herring, though this was supposed to be one of the diminishing fishes not long ago. Yet a word must be said in favour of the Danish exploration of the North Atlantic, where, and in the Mediterranean, Dr. Johs. Schmidt carried out such excellent work on the life-history of the eel.

The hydrographical and plankton work of the Council has hitherto borne little fruit in the matter of the fisheries, and it is unlikely that, after twenty years' probation, more will be accomplished.

The revival of the bathybius-myth in the form of the supposed "vitamines" in sea-water may give point to a sentence, thus: "The searcher for economic results in fisheries must have the basal theory and knowledge . . . as the foundation on which he has to build," but that is *vox et praeterea nihil* unless a practical acquaintance with the whole details of the life-history of the sea-fishes is possessed by him. Mere collation of statistics without such a check is of little avail in the complex problem of the sea-fisheries, which, however, now as heretofore, hold their own against the combined attacks of their own kind, as well as of man, seals, whales, birds, and invertebrates. Marine animals have been kept in pure sea water without food for years, yet the suggested application of the "vitamine" theory to the oyster and mussel does not offer much scope. The best *parcs* for fattening the oysters have much more than "vitamines," and even the *ejectamenta*, etc., of the mussels in the estuaries will by and by raise mounds several feet above sea-level.

Four French names are given as members of the Council, but they are less familiar than those of Fabre-Domergue, Canu, Cligny, Raveret-Wattel, and Pellegrin. Again, one British name is conspicuous by its absence, viz. that of Dr. A. T. Masterman, a highly trained and talented fisheries expert. It is to be hoped that no interference by officialdom, as dealt with in the leading article in NATURE of March 25, is connected with his retirement. Those who remember the case of Sir Joseph Hooker and Mr. Ayrton have reason to be jealous of the official status of experienced men of science in carrying out their researches for the benefit of the country.

Finally, there can be little doubt that Britain would be better and more economically served by competent workers in its marine laboratories, where, moreover, young zoologists could acquire a competent knowledge of the marine fisheries.

W. C. MCINTOSH.

The Plumage Bill and Bird Protection.

THE protection of beautiful and interesting birds is the object of Col. Yate's and Lord Aberdeen's Bill now before Parliament. The chief end is to close Great Britain (and presumably all parts of the British Empire controlled from London) as a market in which the plumage of wild birds (excepting eider down and ostrich feathers) may be bought and sold. The reasons for excepting the down of the eider duck and the plumes of the ostrich need scarcely be explained. The eider duck strips herself of the downy feathers she develops during the breeding season and lines her nest with them. This down can be obtained without injuring the bird, or even without depriving her nestlings, who leave the downy nest soon after birth. Such a large proportion of ostrich plumes is obtained from tame birds (and the wild ostrich chicks are so easily domesticated) that it is scarcely worth while pursuing the wild bird for its feathers. Moreover, the plumes can be removed from the tame birds painlessly.

The Bill is drawn so as to protect wild birds from persecution by closing to the trade in their feathers the very important British market, which, together with the strong action of the United States and Canada, will go far towards extirpating this commerce. We should protect beautiful, useful, interesting, and harmless birds—adjectives which include all the avian class except, perhaps, the house-sparrow, the tree-sparrow, and the wood-pigeon, because:—

(1) They are beautiful in shape, in plumage, in their manner of life, or in their voice, and they always add to the æsthetic charm of a landscape.

(2) The majority of birds feed upon insects, ticks, land mollusca, small rodents, or carrion. They are our principal allies in keeping the insect hosts at bay and destroying the sources and disseminators of germs which breed disease in man, beast, and plant. They save our food crops and our timber-trees from destruction by insects, snails, and slugs; they attack snakes; and they assist to maintain the balance of creation in favour of man.

(3) Sea-birds—especially gulls, auks, petrels, gannets, frigate-birds, cormorants, and penguins—are the producers of guano useful in agriculture and horticulture.

(4) Many fruit-eating birds are great distributors of the seeds, stones, and nuts of valuable timber-trees or trees producing spices, dyes, drugs, or fruits of value to humanity.

Ergo, all birds, save the sparrows and the European wood-pigeon (which is very destructive to crops, and is believed to spread the germs of diphtheria), should be protected from attacks which are not necessitated by some real human need. What would be such a need? The preservation of the bulk of a food crop, or the necessity for the bird's flesh, or the requiring of its under-plumage as a material for warding off cold. The last-named requirement does not affect the tropics or sub-tropics. Most insect-eating or guano-producing birds are unfit for food, and are disliked from that point of view by the savage quite as much as by the white man. Penguins and a few other sea-birds yield a valuable oil, but there is no reason why penguin rookeries should not be established for that purpose provided the species is properly preserved from serious diminution. Yet the amount of oil thus obtained is trifling in comparison with the yield from whales, porpoises, seals, and fish; and these inhabitants of the seas and oceans are more protected by their habitat from devastating attacks than are birds resorting to a terrestrial life during the breeding season. At any rate, the extermination of marine mammals or of fish is not such a loss to landscape beauty or to the economics of human life as is the destruction of sea-birds.

What is the offset against this argument for wild-bird preservation? What quality do beautiful and interesting wild birds possess that they should be attacked, pursued, and destroyed until in many cases they become extinct? They produce feathers and plumes of great beauty in colour or of exquisite outline or texture which are desired as a personal adornment by certain European—not Asiatic, American, or African—women, who stick these trophies in head-coverings or as a trimming on their corsage. There is also in about half a dozen instances a further use of wild birds' plumage in the making of artificial flies used by anglers.

All that European women or anglers can in reason require in the way of plumes, wings, tails, or skins of birds for their decoration or other purposes can be obtained without cruelty from the domesticated or preserved birds that are killed for food or kept for egg production—ostriches, the domestic fowl in a hundred varieties, the common pheasant and other pheasants bred in aviaries, pea-fowl, turkeys, guinea-fowl, pigeons, grouse, partridges, ducks, geese, certain kinds of wild duck sufficiently preserved to be in no danger of dying out, and so forth. Trade in such feathers is in no way restricted by the Plumage Bill. It is not right that rare and beautiful or exceedingly useful wild birds of the tropics and sub-tropics should be destroyed, eliminated from the landscapes for the sole purpose of decorating the persons of European women. We are told that the disuse of this practice would throw out of employment four or five thousand persons in England, France, and Holland; but surely they could find work in dealing with the feathers of domesticated birds.

H. H. JOHNSTON.

St. John's Priory, Poling, Arundel.

IT is desirable in a discussion on the Plumage Bill to ensure that knowledge is not controlled by sentiment, and that the solid facts of the matter are borne definitely in mind. Supporters of the Bill give three main reasons for it. They claim that the Bill will stop (1) the extinction of rare birds; (2) cruelty in that it will stop the killing of breeding birds, and so preserve their young; and (3) cruelty in the actual slaughter of birds at all. Against the Bill are the statements that it effects nothing in regard to these points (in that it has no action in the places where the birds occur); that it stops a great deal of perfectly harmless and legitimate trade; and that the real protection of birds must be an international matter, which was being quite easily brought about by voluntary effort, which effort will be killed by the Bill.

The important points are to consider (1) whether there is cruelty, (2) whether birds are being made extinct owing to the plumage trade, (3) whether the present Bill will prevent cruelty and extinction, and (4) whether any alternative proposal can be suggested. In regard to cruelty, it is extremely difficult to secure real evidence apart from unsupported statements. In a letter to the *Times* a few days ago Mr. H. J. Massingham produced a private letter detailing horrible cruelty in China with getting egret plumage. There is an American bulletin that details the killing of 150,000 or 300,000 "albatrosses and noddies." One may admit the first as "cruelty," but scarcely the second so long as hunting and shooting are carried on in England. The Right Hon. Sir C. E. H. Hobhouse in the House of Commons referred to an auction of 75,000 herons, and to another of 77,000 herons, 22,000 crowned pigeons, 25,000 humming-birds, and 162,000 Smyrnian kingfishers. But is this wrong? No one could say that this trade was making any bird extinct.

The trade wants them in thousands, and would not seek a bird so rare that it was available only in hundreds.

I think there is no evidence of any bird being made extinct by acts of the plumage dealers, whose interest lies in birds being abundant, but the Bill allows the scientific collector to bring in the rarest plumage. In this connection some persons emphasise the destruction of insectivorous birds as being a pity; but an insectivorous bird may itself destroy beneficial insects—say, dragon-flies, which themselves feed on mosquitoes.

Mr. C. W. Mason and I have published a very careful analysis of the food of birds in India, and we decided that herons were injurious (see Memoirs of the Agricultural Department of India, vol. iii., 1911). I have before me three such memoirs, all by entomologists, relating to England, Australia, and India; and it is necessary to distinguish very clearly what the value of a bird is. Apart from this, no one interested in Nature could desire the extinction of any species of bird or other life at all, and we need not restrict our precautions solely to beneficial birds.

The third point is whether the proposed Bill will protect the birds. It will not, because it simply prohibits importation into England of all plumage except ostrich and eider down, unless it is worn or is personal property. The plumage goes just the same to Paris, and no bird is protected at all. The same amount of plumage will come to England, only it will be all made up in Paris.

The fourth point is: What can be offered in its place? I suggest the Bill should prohibit the import of scheduled birds, and that if evidence is brought of cruelty or of approaching extinction, the importation of the bird from that locality should be prohibited by simply adding it and its locality to the schedule. There might well be a Standing Committee attached to the Board of Trade to hear representations and to vary the schedule.

The egret is greatly mentioned. It is said to be destroyed for its plumes while the young birds are still helpless in the nest; but I have photographs of an egret farm in Sind, and there are hundreds of such farms. The egrets' plumes are taken without cruelty, and the birds are not killed. Why, then, indiscriminately forbid egret plumes and destroy an industry in India? Why not exclude Chinese egret, and represent the matter to the Chinese Government? Why bar also the possibilities of farming emu, rhea, marabou, lyre-birds, pheasants, etc.?

The Committee for the Economic Preservation of Birds up to August, 1914, endeavoured to put this matter right. It is a fact that this Committee had secured the co-operation of the plumage trade of Paris, Vienna, Berlin, and London, and that the whole trade voluntarily stopped the import and use of the plumage of a number of birds which were thought to be in danger of extinction or to be beneficial. This was the only effort to secure the real remedy, international co-operation; and the present Bill completely wipes out that possibility.

Perhaps the present discussion will produce the solid evidence (apart from opinion) on which the supporters of the Bill rest; up to the present there has been little other than sentiment.

One last point that has a scientific bearing is that the Bill allows the importation of plumage for scientific purposes and for museums. The scientific collector specialises on rarities which the museums need, and it is exactly this type of collector who needs to be stopped; but the Plumage Bill is backed precisely by the ornithologists who want rare skins, and so can get them.

I think the Bill needs a great deal of reconsideration, that a reasonable Bill can be drafted which will protect birds, and that the present one allows for the collection of the nearly extinct birds and does nothing to protect the cases where there is cruelty.

H. M. LEFROY.

IF I were still in Parliament I should give as cordial support to the Importation of Plumage (Prohibition) Bill as I would have done to the late Lord Avebury's Bill had I been in the House of Lords when he introduced it. But I recognise that if the measure is to receive support from men of science, it must be based mainly on scientific rather than on humanitarian or sentimental grounds.

I notice that Prof. H. M. Lefroy, in a recent letter to the *Times*, seems to assume that the advocates of prohibition are actuated by sentiment only. He asks whether they consider it less cruel to kill spring chickens for their flesh than pretty birds for their plumage. If this is meant for argument, it seems particularly feeble, unless the whole question of the ethics of consuming animal food is to be raised. If it were as easy to rear egrets, birds of paradise, rifle-birds, etc., for the sake of their plumage as it is to rear cattle, sheep, and domestic fowls for their flesh, probably none but extreme humanitarians would raise serious objections, even if the birds had to be killed, which is not necessary in ostrich-farming. From a scientific point of view, the matter seems to resolve itself into the question whether the extinction or drastic reduction of the most beautifully clad birds can be viewed with indifference. I cannot speak at first hand about the extent to which reduction has been carried, but the evidence on this subject has proved sufficient to convince the Legislature of the United States that restriction of the plumage trade was necessary if some of the choicest species were to be saved from extinction.

I cannot but hold the conviction that the true functions of naturalists are not limited to the mere work of collecting, recording, and classifying, and that it is incumbent upon them to aid in resistance to the extermination of such existing species as do not interfere with the welfare of human beings. But, after all, I can claim no higher standing than that of a field-naturalist, setting more store on a bird in the bush than two in a glass case or on a lady's hat!

HERBERT MAXWELL.

Monreith.

THE subject of the Importation of Plumage (Prohibition) Bill now before Parliament is one in which all zoologists, and, indeed, all lovers of Nature, should take a lively interest. It seems almost certain that much cruelty is involved in the operations of plume-hunters, and it is difficult to see how it could be otherwise, especially when the plumes are collected during the breeding season. This question, however, I leave to others who have the necessary evidence at hand, together with the important problem of the part played by the birds in the destruction of noxious insects.

The point I wish to emphasise is the irreparable loss, not only to science, but also to mankind in general, which will result from the extermination of many of the most interesting and beautiful creatures that exist. Unfortunately, there appears to be no limit to the lust of personal gain. Were it possible to pluck a star from the heavens and sell it for the decoration of a lady's headdress, star-hunters would doubtless be as active as plume-hunters in destroying man's rich inheritance.

It is clearly our duty to preserve for future generations, as well as for our own enjoyment and edifica-

tion, the wonderful products of Nature by which we are still surrounded. The destruction of a work of art would be condemned as vandalism by all educated people, and it is difficult to believe that any intelligent woman would willingly be a party to the destruction of some of Nature's finest masterpieces. It has taken many millions of years to produce a humming-bird or a bird of paradise, and what work of art can compare with these living gems? Their destruction, once accomplished, would be irrevocable, and future generations of zoologists, with all their science of genetics, might strive in vain to produce anything to replace them.

Should such wantonness be permitted merely to satisfy the greed and vanity of a few human beings? I think not, and therefore I hope the Plumage Bill now before Parliament will be passed, and that other nations will follow our example in endeavouring to put a stop to a practice which is a dark blot on civilisation.

Possibly an even more hopeful method of accomplishing this aim would be by the formation of women's societies for the express purpose of discountenancing the fashion of wearing plumage derived from wild birds, except in the case of those the destruction of which is demanded for other and sufficient reasons. Such societies might do much useful work in enlightening the ignorant and thoughtless and in fostering a wholesome public opinion. Possibly they exist already; if so, now is their opportunity.

ARTHUR DENDY.

The Magnetic Storm of March 22–23 and Associated Phenomena.

THE magnetic storm of March 22–23 was one of the most considerable recorded at Eskdalemuir during the last nine years throughout which continuous records have been obtained. It began with the abrupt disturbance known as a "sudden commencement" at 9h. 12m. G.M.T. on March 22, the rapidity of the change in the horizontal components at that time being so great that the photographic impression of the moving light-spot was too faint to enable its details to be traced. The main features, however, began to develop immediately afterwards. On the traces recording the changes in declination and the westerly component there were no very large motions in the interval between the sudden commencement and 14½h., but there occurred the intense agitation due to oscillations of short period. At the same time the northerly component of force gradually rose, having superposed upon it several large, slow motions as well as numerous short-period oscillations.

The larger motions of both horizontal components began soon after 16h., and by 17h. the declination trace had passed beyond the edge of the recording sheet. At this time, when the extreme westerly declination was reached, its value must have been at least 1° 43′ beyond its undisturbed value. The north component trace was similarly off the sheet upwards (*i.e.* with increased value) from 16h. to 20h. From 20h. until midnight the disturbance in the horizontal field was on a lesser scale, but during the four hours after 0h. 30m. there occurred a series of large and rapid oscillations. For example, in six minutes from 1h. 20m. to 1h. 26m. the declination shifted eastwards through 2½°. The northerly component fell rapidly in value after midnight, and the trace was off the sheet downwards several times between 0h. and 4h. The total range of this component must, therefore, have exceeded 700γ—an unusually high value. From 4h. to 10h. on March 23 the motions were smaller, but extremely rapid, the period averaging about four minutes. After 10h. no further considerable disturbance occurred, but a notable sudden change, in a direction north-east-downwards, took place with its maximum at 19h. 17m.

The vertical force magnetogram for the storm is of more than usual interest. So far as this component is concerned, the ordinary course of events during a magnetic storm which begins before midnight includes a gradual increase in downwards force towards a maximum which is reached before midnight, followed by a fall for an hour or more; then a check, followed by a further fall, and a gradual recovery to nearly normal value, which may be reached about 8h. In the present case four prominent maxima are shown before midnight—at 14h. 27m., 17h. 24m., 20h. 10m., and 23h. 49m. The range of disturbance between the second and highest maximum and the second minimum (at 19h. 6m.) was 565γ. Soon after midnight there occurred an extremely rapid fall in value which sent the trace off the sheet for nearly six hours. The subsequent recovery was characterised by well-marked pulsations the period of which was irregular, but averaged about five minutes, and were of unusually large amplitude. The occurrence of these pulsations in vertical force *at the end* of a storm is a feature requiring attention in any theory attempting to explain magnetic storms.

The disturbance was accompanied by an auroral display, including the "curtain" form at a considerable altitude, and extending, at 0h. 50m. on March 23, to within 30° of the southern horizon. There was little cloud at the time, but low mist made observation of details difficult.

A. CRICHTON MITCHELL.

Eskdalemuir Observatory, March 26.

Science and the New Army.

NATURE of March 25 publishes a leading article "Knowledge and Power," a letter from Col. E. H. Hills, and a paragraph in the "University and Educational Intelligence," all dealing with related subjects. A sentence in the last-named paragraph throws light on the other communications. It reads: "Every officer in command of a company will be held responsible for the instruction of his men." The paragraph neglects to state, however, that the majority of these officers entered Sandhurst or Woolwich at an immature age, probably without competition, and are almost as ignorant as the men whose education they are to supervise.

During the war the lack of scientific knowledge and of habits of exact thought of these officers was shown not only by their persistent attempts to prevent the use of scientific means, but also by their child-like faith in a formula or parrot-cry. "Follow the barrage," "Counter-attack," "Defence in depth," are some that come to mind—formulæ passed down through the official channels to be applied without thought to all possible situations.

In this country war is still looked upon as an art, whereas it is rapidly becoming an exact science.

The firing of millions of projectiles, involving an enormous expenditure of energy, not only in lives, but, what counts almost as much in the long run, also of labour, is a matter for exact calculation if the maximum probable results are to be obtained. At the present time such problems are solved by intuitive methods, and will be so whilst the present system of officering the Army obtains.

All hope of any real progress must be abandoned until a change is made; then, perhaps, we shall no longer see directors of research absolutely ignorant of the problems that are being solved or await solution.

A. R. RICHARDSON.

Imperial College of Science, South Kensington, S.W.7, March 31.

An Electronic Theory of Isomerism.

I HAVE read with considerable interest the suggestion of Dr. H. S. Allen in NATURE for March 18 that the Langmuir atom could be applied with advantage to the study of organic compounds. Dr. Allen is, however, doubtful if the "cubical atom" of Langmuir will explain the existence of isomerides of the type of the three malic acids, the glutaconic acids, the cinnamic acids, α-, β-, and γ-sugars, etc.; and it is certainly difficult to give formulæ for the triple linkage on the cubical atom. These difficulties disappear with the Bohr atom (NATURE, February 19, p. 661) and the modification of the Langmuir atom proposed by Major A. E. Oxley (*ibid.*, March 25, p. 105). With both theories n and s valencies are obtained, and, so far as a qualitative examination of valency in organic chemistry is concerned, it is difficult to decide between the two models. Major Oxley has, however, shown that his theory can give an adequate explanation of the magnetic properties of organic compounds, and equal success may be obtained with a theory of optical activity.

The crucial test appears to lie in the calculation of the optical activity of substances in the crystal form, for it is probable that in the liquid condition a large number of isomeric forms exist.

The alterations in optical activity which occur with change of solvent and the phenomena of mutarotation and of racemisation appear to be connected with changes in the direction of rotation of electrons. These changes could, perhaps, be more easily explained by the small orbital motions demanded by the Langmuir theory than by the larger orbital motions in the theory of Bohr.

W. E. GARNER.

University College, London.

IN view of Dr. A. E. Oxley's remarks in NATURE of March 25, I should like to point out that the object of my letter was to inquire whether the supposition of stationary electrons is essential to Langmuir's theory. Langmuir himself expressed the hope that it would be possible to reconcile his theory with that of Bohr, "which has had such marked success in explaining, and even in predicting, new facts." I ventured to suggest that electrons revolving round the nucleus could form stable groups as required by Langmuir without needing to be stationary.

The difficulty of explaining diamagnetism on the theory of the astronomical atom is well known. Possibly the difficulty may disappear when the nucleus is better understood. If electrons are considered as point-charges, the supposition that they revolve in very small orbits without any constraining force seems arbitrary. Dr. Allen's theory of ring electrons is preferable, and undoubtedly removes certain difficulties. It appears, however, that to account for spectral lines the diameter of the orbits must be comparable with that of the atom, which implies that the electrons revolve round the nucleus.

Since the structure of the atom is still uncertain, would it not be preferable to avoid, if possible, in a chemical theory a statement as to the immobility of the electrons?

S. C. BRADFORD.

Science Museum, South Kensington, S.W.7.

Percussion-Figures.

C. V. RAMAN describes in NATURE of October 9, 1919, percussion figures in isotropic solids. These figures are known in geology, and are found on rounded boulders of compact, homogeneous rocks, such as flint and quartzite. Albert Heim [1] described in 1871 the "percussion-cones" (Schlagconus) brought forth artificially on pieces of flint by a powerful short blow with a hammer. F. Mühlberg,[2] of Aarau (Switzerland) was perhaps the first geologist who described the percussion-figures (Schlagfiguren) on rounded boulders (1885). On some of the quartz-boulders from the River Aar, near Aarau, he found from hundreds to thousands of circular cracks, which he explained by the abrasion of boulders which formerly received coniform cracks through the numerous impacts during their transport through the river-bed.

These percussion-figures must be intersecting figures of cones and the surface of the boulder, and, therefore, will form, on sufficiently great boulders, nearly circles, ellipses, and parabolas. Mühlberg described thus percussion-figures arising from torrent-action, whereas A. Bigot [3] (1907) emphasised that the "figures de percussion" arise from wave-action. He noticed them on the beaches of Basse-Normandie, particularly on quartzite boulders. Finally, P. N. Peach [4] (1912) gave a very fine picture of the "bulbs of percussion" found on a rounded stone (chalk flint) dredged by the *Michel Sars* about 230 miles south-west of Mizen Head, Ireland. He pointed out that these figures indicate that "the stones had originally been dashed against each other by torrent- or wave-action."

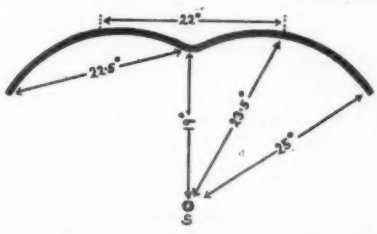
Besides the term above-mentioned, Peach also uses the term "chatter marks," which seems to me less commendable, because this expression is also used by T. C. Chamberlin [5] for a special type of glacial striæ on the rock-bed. These curved figures were also described by Hagenbach in 1883, and afterwards called "arcs de Hagenbach" by L. Rollier.[6]

Batavia, Java, February 11.

B. G. ESCHER.

A Peculiar Halo.

ON March 16 I observed a peculiar halo here; its form is best shown by a rough sketch. The angles were taken with a pocket slide-rule held at arm's length, and are, therefore, only approximations, but the relative values are probably fairly correct. The halo was brightest at the point above the sun, and faded off somewhat on each side; it ended rather abruptly at the points shown in the sketch. The



colours, with red nearest the sun, were not very pure, but they were purer in the arms than in the centre. The phenomenon was visible from 14.45 to 15.40, with intervals of disappearance when a sheet of alto-stratus became so thick that nothing could be seen through it but the glare of the sun. It was not possible to see any higher layer of cloud, but the halo probably had its origin in a layer of cirro-stratus. The measurements were taken at 15.40; a few minutes later the halo disappeared for the last time.

C. J. P. CAVE.

Sherwood, Newton St. Cyres, Devon,
March 20.

[1] *Vierteljahrsch-ift der Naturf. Gesellschaft in Zürich*, 1871, p. 140.

[2] *Programm der Aargauischen Kantonschule*, Aarau, 1885; *Die heutigen und früheren Verhältnisse der Aare bei Aarau*, p. 4.

[3] *Bull tin de l : Soc. géol. de France*, 4e série, tome iv. (1904), p. 598.

[4] Proc Roy. Soc. Edin., 1912; also Murray and Hjort, "The Depth of the Ocean," p. 205.

[5] 7th Ann. Rept. U.S. Geol. Survey, p. 218.

[6] *Bu'letin de la Soc. Belfortaine d'Emulation*, No. 27, 1908.

Sea-birds: Their Relation to the Fisheries and Agriculture.

By DR. WALTER E. COLLINGE.

DURING the past few years there has been a growing opinion on the part of the general public and those connected with our fisheries that the enormous number of sea-birds on our coasts are inimical to the fisheries and to a less extent to agriculture. This view has been fostered to a large degree by the public expression of irresponsible statements and by the fact that we do not possess any exact and trustworthy knowledge of the nature of the food of these birds. Even amongst ornithologists and other students of wild-bird life widely divergent views are held.

Hitherto no investigation sufficiently comprehensive has been made, and in those cases where the birds of a restricted area have been studied, or where an insufficient number of specimens has been examined, the results have proved inconclusive, and, owing to the methods employed, to some extent misleading.

About two and a half years ago, under the auspices of the Carnegie Trust for the Universities of Scotland, an investigation was commenced in which it was proposed to examine large series of each species from numerous localities during each month of the year, and to estimate the food by the volumetric method. Although this research is not yet complete, sufficient data are in hand to warrant an expression of opinion upon this subject, and it is felt that such is highly desirable at the present time, when so many erroneous views are being circulated.

Up to the present, fourteen species have been examined, represented by upwards of three thousand specimens. The species are cormorant, shag, common gull, herring gull, great black-backed gull, lesser black-backed gull, black-headed gull, kittiwake, common tern, razorbill, guillemot, little auk, puffin, and great northern diver. Whilst it is not possible here to reproduce the numerous percentage tables showing the nature of the food for each species during the various months of the year, or those illustrating the seasonal variations or the percentages of the different species of fish destroyed, it is possible to make a general statement which we believe future work will more fully amplify and confirm.

First, we would point out that the importance and amount of fish that has been generally regarded as forming the diet of most of these birds are not borne out by an actual examination of their crop and stomach contents. Fish does not (with such exceptions mentioned later) constitute the bulk of their food or anything like the major portion of it. Indeed, one has only to watch carefully such species as the black-backed gull, the herring gull, and the lesser black-backed gull on the shore after the ebb of the tide to realise how essentially these birds are the scavengers of the shore. If they turn landwards, then injurious insects, earthworms, frogs, and carrion are greedily fed upon. Further, if one confines one's observations to birds drowned in the fishermen's nets, entirely misleading ideas are obtained, for these few birds constitute but the merest fraction of the huge bird population frequenting our coasts.

The above-mentioned fourteen species may be divided into three classes, viz.: (i) Purely fish feeders; (ii) largely fish feeders, but most of the fish are not utilised by man as food; (iii) fish feeders to less than 20 per cent. of the total bulk of their food. Most of the species fall into class (iii). In class (i) is placed the cormorant and shag, for, so far as observations go, their food consists entirely of fish, and chiefly of food fishes. In class (ii) is placed the common tern. The remaining eleven species must all be placed in class (iii).

From information obtained from various sources, there is a general consensus of opinion that the cormorant and the shag do an enormous amount of harm to the fisheries. Nothing can be advanced in their favour, though it is open to question whether our fish supply would show any increase even were these birds exterminated. Respecting the common tern, sand eels constitute fully 50 per cent. of its fish diet; the gunnel or butter fish, gobies, young gurnard, herring, and haddock are also taken.

It is not possible here to give the details of the analyses for all the remaining species; we shall therefore select one, the black-headed gull. More than five hundred specimens of this species have been examined, obtained from various localities and during each month of the year. This species is selected because it has increased enormously during the last twenty years, and is now generally regarded as one of the most injurious both to the fisheries and to agriculture.

Of the total bulk of food consumed in a year, 96 per cent. consists of animal matter, and 4 per cent. of vegetable matter. Of the former the actual amount of food fishes found was 11·5 per cent., and of other fishes (not utilised by man as food) 9 per cent., or a total fish diet of 20·5 per cent. Edible crustacea are present to the extent of 4 per cent., and other forms, non-edible, to that of 10 per cent. Marine worms constitute 18·5 per cent., molluscs 4 per cent., echinoderms 2·5 per cent., injurious insects 22 per cent., other insects 1·5 per cent., earthworms 10 per cent., and miscellaneous animal matter 3 per cent. Of the vegetable matter, 2·5 per cent. consists of cereals, and 1·5 per cent. of miscellaneous matter (Fig. 1).

If the huge bulk of food from which these figures have been obtained means anything at all, it indicates clearly and definitely that this species is a highly beneficial one. By no reasonable deduction can it be shown to be otherwise, for nearly two-thirds of its food is of a neutral nature, viz. 60 per cent. (38 per cent. of which consists of shore refuse.) Only 18 per cent. is injurious, and 22 per cent. is highly beneficial. We

feel certain that no one who has had experience in work of this character will for a moment question whether this percentage of food, which is conferring a benefit upon agriculture, balances the injury that is inflicted upon an inexhaustible and ever-increasing fish supply.

Very similar figures might be advanced for the remaining species, none of which are taking more than 20 per cent. of fish per annum of their total bulk of food. Is the sea so impoverished that we cannot afford these birds this amount of fish-food in exchange for their beneficial action in destroying more than 20 per cent. of injurious insects (of which 7·2 per cent. consist of wireworms in the case of the black-headed gull)?

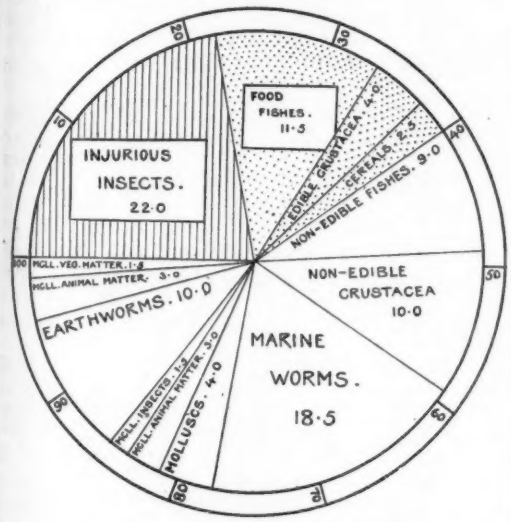


FIG. 1.—Diagrammatic representation of the percentage of food of the black-headed gull. The portions shaded by longitudinal lines represent food that it is beneficial the birds should eat; those stippled, food that it is injurious they should eat, and the blank portions food of a neutral nature.

The records, both individually and collectively, show that the bulk of the food of these birds is not fish, but animal matter of a neutral nature. Of course, if one classes all annelids, non-edible crustacea, and molluscs as fish food, then very different figures may be obtained; but those who are acquainted with the abundance and the nature of the marine life cast up on the shore will agree with us in regarding these as a neutral factor.

If the figures are summarised for all the species in class (iii) (so far as our investigation has gone), the verdict is certainly in favour of these birds. It is very easy to condemn a species because at some particular season of the year or in some district a certain number have been found to be feeding upon food fishes; but, as has been frequently pointed out, such partial records do not give a true estimate of the food as a whole. It must not for one moment be thought that we are endeavouring to explain away the injuries inflicted, but we contend that it is unfair to judge any species of wild bird upon a local or partial record; the nature of the food generally throughout the United Kingdom and over the whole year is what we have endeavoured to learn.

Very interesting results have been obtained as to the seasonal changes of food and the variations in different localities. Sex and age also influence the quantity of food taken, and although the figures are yet incomplete, they point to the fact that the males take a larger quantity of food than the females, and the young birds more than the old.

It is not within the province of this inquiry to discuss the question of the impoverishment of the sea, but it will be impossible to conclude it without taking cognisance of the leading views on the subject and their bearing upon this question.

Finally, all the work goes to show that with a few exceptions—*e.g.* the cormorant and the shag—the food of each species is partly beneficial, and, even if for the moment we admit that the percentage of the fish destroyed is an injury, we must take into consideration the benefits derived by reason of the nature of the remaining food. This varies in different seasons of the year and according to the nature of the locality, but if an average is taken of the eleven species in class (iii), we find that the total percentage of injuries is less than that of the benefits, and that the bulk of the food is of a neutral nature.

It is obvious that, after examining upwards of three thousand specimens, with the results obtained, the question of the food of our commoner sea-birds and their effect upon the fisheries and agriculture can no longer remain where it was; and, whilst not advocating any special protection, except in one or two cases, any agitation for their destruction cannot be condemned too forcibly, for, altogether apart from sentimental reasons, it is extremely unlikely that our fisheries would benefit or show any marked improvement, even were hundreds of thousands of these birds destroyed annually, whilst agriculture would certainly be the sufferer by such a loss.

The Imperial College of Science and Technology.

THE Chancellor of the Exchequer, speaking in the House of Commons on March 16, expressed concern at the extraordinary expansion of business in the promotion of companies, and said he was convinced that the time had come when part of the money thus called for only creates increased competition for the limited supplies of labour and material which are all that are available. Few of us can doubt that this concern of the Chancellor is more than justified, but it is not only for purely industrial enterprise that appeals to the public at large are being made daily for large sums of money. Owing to the universal rise in prices, educational institutions

find themselves seriously handicapped in their endeavours to fulfil the functions assigned to them. In the case of such educational institutions as the schools and colleges maintained wholly, or almost wholly, from rates and taxes, the solution is less difficult, and may be found in an increased education rate combined with an increased Government grant. For the universities which have to depend largely upon fees and endowment, and can rely only partly on Government grants, the difficulties created are very serious. It should, however, be borne in mind that money expended on education is one of the most productive forms of national expenditure, and, whatever may be the dangers of the inflation of industrial capital, the nation is not yet within remote danger of educational inflation. Rather is it suffering grievous detriment from the semi-starvation of its higher educational institutions.

Among the higher educational institutions which are in need of financial help, the Imperial College of Science and Technology holds a prominent place, and an appeal issued some months ago by the governing body makes clear the magnitude and urgency of this want. The Imperial College of Science and Technology was incorporated under Royal Charter in July, 1907, and was established "to give the highest specialised instruction and to provide the fullest equipment for the most advanced training and research in various branches of science, especially in its application to industry." The governing body was also required to carry on the work of the Royal College of Science, the Royal School of Mines, and the City and Guilds (Engineering) College, institutions previously existing, but which in 1907 became associated as integral parts of the new institution.

The Imperial College is thus an association or federation of colleges, deliberately charged by the terms of its charter to afford facilities for the highest work in pure and applied science, especially in its application to industry. As an indication of the magnitude of its work, it may be noted that in the year 1907–8 there were 665 students, including 20 engaged on post-graduate work, and the annual expenditure on maintenance approximated to 50,000*l*. In the year 1913–14—the year before the war—the number of students was 943, including 185 engaged on post-graduate work, and the annual expenditure on maintenance approximated to 90,000*l*. During the war the numbers of students were reduced by about two-thirds, but in May last year there were 841, including 110 post-graduates, and as the numbers are rapidly increasing there is every indication that the college will soon be busier than ever before. On the basis only of the pre-war annual expenditure, the Imperial College is as large as Manchester University, larger than Liverpool University, and twice as large as Bristol University. Its rank in science and technology, whether viewed from the range and standard of its teaching and research, or from its equipment, is at least as high as that of any existing university in Great Britain.

In order that the college may rise to the height of its responsibilities and fulfil the functions assigned to it by its charter, the governing body estimates that for new buildings and equipment at least 600,000*l*. is required, and for the adequate development of the work of the college a further annual income approximating to 100,000*l*. The capitalised value of the total additional requirement has been put in round figures at more than 2,000,000*l*. It is large, but much less than the amount required for a modern battleship, and is not incommensurate with the importance to the nation and the Empire of the work which the college has to do.

From a quarter to one-fifth of the total number of students are carrying on original investigations under the direction of their respective professors, and this, together with the research work of the staff, results in considerable additions to knowledge annually. The investigations range over a wide area of science, especially in its application to industry. The contributions thus made to increased industrial efficiency are no mean factor in the national development and prosperity. At the same time, in the course of these investigations the relevant researches in pure science are not neglected, and thus much is done continually to widen the bounds of knowledge as knowledge.

The teaching work carried on in the college may be divided into (*a*) associateship and (*b*) post-associateship. The former consists of courses, approximately of honours graduate standard, leading respectively to associateships of the Royal College of Science (A.R.C.S.), the Royal School of Mines (A.R.S.M.), and the City and Guilds Institute (A.C.G.I.); and the latter of courses of study and of research, comparable in standard with M.Sc. and D.Sc. work, leading to the diploma of membership of the Imperial College (D.I.C.).

Styled "Imperial" from the first, the college has constantly to bear in mind the growing industrial needs not only of the Kingdom, but also of the Empire, and to do this it must possess a flexibility and an adaptability suitable to the ever-changing conditions of industry. To take one example, the war disclosed, as in a flash, the perilous condition of the optical glass and optical instrument industry in this country through the dependence for many years on foreign supplies, particularly from Germany. A new department of technical optics has been established by the governors of the Imperial College, which, by research, by the supply of trained technologists in this field, and by the education of the users of optical instruments, must go far to second the efforts of the manufacturers to build up and stabilise this important and essential national industry. At no time was the need for an intensive and extensive development of science, both pure and applied, more needed than at the present time of national reconstruction after five

years of a devastating world war, and in this task of extending our knowledge of pure science and its application to the whole field of industry the Imperial College is called upon to play a vital and predominant part.

The recognition of how great and important are the responsibilities thus cast upon the Imperial College has led to a movement for obtaining for the college the status of a university with the power to confer degrees in its own subjects or faculties. The movement is backed by the unanimous support of the rector and professors of the Imperial College, and it is supported, so far as can be ascertained in any organised way, by the overwhelming majority of the past and present students of the college. The issue raises, no doubt, questions that are novel and complicated in relation to university education in general and to the University of London in particular. Nothing but good can come from a free and frank examination of the proposition in all its bearings, undisturbed and unprejudiced by lesser interests than that of increasing the efficiency of university education and especially of scientific education.

Magnetic Disturbances and Geological Structure.[1]

THE research described in the report before us was undertaken at the instigation of the Iron Ores Committee of the Conjoint Board of Scientific Societies. Certain lines and centres of magnetic disturbance had been noted in Britain so long ago as 1890 by Rücker and Thorpe, and a new magnetic survey by Mr. G. W. Walker in the years 1914 and 1915 confirmed the existence of these disturbed areas. It is well known that iron is the only element which gives rise to magnetic effects of considerable intensity, and it was therefore of importance to determine whether any relationship could be established between the location of these disturbances and the distribution of iron ores.

The detailed magnetic survey of (1) the proved sheet of iron ore, mainly in the state of ferrous carbonate, round Irthlingborough, and (2) the known areas of magnetic disturbance about Melton Mowbray, was therefore undertaken by Mr. Walker. At the same time, Dr. Cox reviewed the geology of the areas and collected specimens of rocks which promised to afford evidence in the matter, while the magnetic susceptibilities of these materials were determined by Prof. Ernest Wilson.

The results of the magnetic and petrological examination of the rocks confirm the opinion that the magnetic susceptibility of rocks depends scarcely at all upon the percentage of metallic iron they contain, but upon the condition—*i.e.* state of oxidation—of that iron; and that, although rocks composed of ferrous compounds show higher susceptibilities than those constituted of fully oxidised ferric compounds, only those rocks in which the iron occurs as the mineral magnetite have notable magnetic susceptibility. It was shown that parts of the granite of Mount Sorrel have a susceptibility more than four times as great as that of the most magnetic of the local Jurassic iron ores, and ten to fifteen times as great as certain basic igneous rocks, which, though high in iron, contain no appreciable amount of magnetite.

Another point of some interest is the variability of magnetic properties shown by samples taken from one continuous rock mass. The outer part of the dolerite sill proved in the Owthorpe borehole was a fine-grained rock having a glassy base; its iron ore occurs as magnetite, and the magnetic susceptibility of the specimen examined was 472×10^{-5} C.G.S. units. The coarse-grained rock from the centre of the intrusion, however, in which the iron ores crystallised as ilmenite, gave a susceptibility of only $10{\cdot}3 \times 10^{-5}$ C.G.S. units. A like low susceptibility was noted also in the basalt from the Southwell borehole.

The magnetic phenomena of the Irthlingborough district are adequately explained by the presence of such a large, flat-lying sheet of feebly magnetic rock as the Bajocian iron-ore bed, but in the Melton Mowbray district the proved limits of the marlstone iron-ore bed bear no relation to the observed magnetic phenomena. Moreover, the consideration of the magnetic irregularities obtained in the Melton Mowbray district shows that the source of the disturbance cannot be less than 3000 ft., and may be as much as 10,000 ft. beneath the surface. The only rocks in this region which have the requisite magnetic susceptibility and may be expected to occur at these depths are dolerites, such as are found intrusive into the Coal Measures throughout the Midland coalfield area, or possibly granites like those which have invaded the old pre-Carboniferous rocks in Charnwood Forest.

Mr. Walker's observations show that, near to Melton Mowbray, there are two main magnetic disturbances, and that the line joining them ranges north of west and south of east from Melton Mowbray towards Rempstone, passing a little south of the latter place. This line agrees with that of a known fault of small throw which cuts the Mesozoic rocks, and may be expected to have a much larger throw in the Palæozoic and older strata underground. Similar magnetic disturbances are noted near certain large faults in the Nottingham district. Rücker and Thorpe showed that magnetic disturbances are always to be expected where a sill or dyke of highly susceptible rock is displaced by a fault, and that, if any rock containing magnetite is intruded as a dyke among non-susceptible rocks, similar magnetic disturbances must occur. It is known that in many districts the place of intrusions has been determined by faulting, and it is pointed out by Dr. Cox that the concealed coalfield of Notting-

[1] "A Report on Magnetic Disturbances in Northamptonshire and Leicestershire and their Relations to the Geological Structure." By Dr. A. H. Cox. Phil. Trans. Roy. Soc., Series A, vol. ccxix., pp. 73–135; plates Ap. i.–Ap. iii.

hamshire should end off at an anticline, probably faulted, in the region about Melton Mowbray. Such an anticline has an east-and-west trend, and carries round the strike of the Coal Measures from its general north-east-and-south-west to an east-and-west direction. The Rempstone-Melton Mowbray magnetic disturbances, therefore, are interpreted as additional evidence of the existence of a fault which in the underlying Palæozoic rocks may have a considerable throw; and it is regarded as probable that a sill of dolerite is displaced by this fault, or that an irregular mass of dolerite is intruded along it.

The hope is expressed by the author that a like method of attack may prove to be of use as a guide to the divining of the position of faults beneath a cover of unconformable strata in other districts—*e.g.* in concealed coalfields, where dolerites or other rocks containing a high proportion of magnetite are present. Unfortunately, however, or fortunately from the point of view of the coal miner, dolerites are not an invariable concomitant of coal seams, and it therefore follows that the use of the method in determining the limits of concealed coalfields would appear to be somewhat restricted.

British Crop Production.[1]

By DR. EDWARD J. RUSSELL, F.R.S.

CROP production in Britain is carried on in the hope of gain, and thus differs fundamentally from gardening, which is commonly practised without regard to profit and loss accounts. Many poets from times of old down to our own days have sung of the pleasures to be derived from gardening. But only once in the history of literature have the pleasures of farming been sung, and that was nearly two thousand years ago.

> Ah! too fortunate the husbandmen, did they but know it, on whom, far from the clash of arms, earth their most just mistress lavishes from the soil a plenteous subsistence.—"Georgics," Bk. II., i., 458 *et seq.*

"Did they but know it"! Even then there seem to have been worries!

This seeking for profit imposes an important condition on British agriculture: maximum production must be secured at the minimum of cost. This condition is best fulfilled by utilising to the full all the natural advantages and obviating so far as possible all the natural disadvantages of the farm—in other words, by growing crops specially adapted to the local conditions, and avoiding any not particularly well suited to them.

From the scientific point of view the problem thus becomes a study in adaptation, and we shall find a considerable interplay of factors, inasmuch as both natural conditions and crop can be somewhat altered so as the better to suit each other.

It is not my province to discuss the methods by which plant-breeders alter plants; it is sufficient to know that this can be done within limits which no one would yet attempt to define. The natural conditions are determined broadly by climate and by soil. The climate may be regarded as uncontrollable. "What can't be cured must be endured." The scheme of crop production must, therefore, be adapted to the climate, and especially to the rainfall.

The rainfall map shows that the eastern half of England is, on the whole, drier than the western half. In agricultural experience, wheat flourishes best in dry conditions and grass in wet conditions; the vegetation maps show that wheat tends to be grown in the eastern and grass in the western part. The strict relationship is that seed production is appropriate to the drier, and leaf production to the wetter, districts.

The great soil belts of England south of the Trent run in a south-westerly direction; north of the Trent, however, they run north and south. A heavy soil, like a wet climate, favours grass production; a light soil, like a dry climate, is suitable for arable crops. The great influence of climate is modified, but not overridden, by the soil factor.

The arable farmer grows three kinds of crops: corn, clover or seeds hay, and fodder crops for his animals or potatoes for human beings. The same general principles underlie all, and as corn crops are of the most general interest (though not necessarily of the greatest importance), they will serve to illustrate all the points it is necessary to bring out. We have seen that wheat is cultivated more in the eastern than in the western portion of the country. The figures for consumption and production are as follows:—

Millions of Tons per Annum.

	Consumption in United Kingdom	Production in England and Wales			Production in United Kingdom		
		Before war 1914	1918	1919	Before war 1914	1918	1919
Wheat ..	7·40	1·6	2·3	1·8	1·7	2·0	2·0
Barley ...	1·96	1·2	1·2	1·1	1·6	1·5	1·3
Oats ...	4·30	1·4	2·0	1·6	3·0	4·5	4·2

During the war very serious attention was paid to the problem of reducing the gap between consumption and production. A working solution was found by lowering the milling standard, retaining more of the offal, and introducing other cereals and potatoes; a very considerable proportion of the resulting bread was thus produced at home. But the war-bread did not commend itself, and disappeared soon after the armistice; since then the consumption of wheat has gone up, and the divergence between consumption and production has again become marked. There is no hope of reducing consumption; we must, therefore, increase production. Additional production may be obtained in two ways: by increasing the yield per acre, and by increasing the number of acres devoted to the crop.

The yield per acre is shown in the following table:—

Measured Bushels per Acre.[2]

	(1908-17) Average yield per acre		A good farmer expects	Highest recorded yield
	England and Wales	Scotland		
Wheat ...	31·0	39·9	40 to 50	96
Barley ...	31·9	35·4	40 to 60	80
Oats ...	39·3	38·9	60 to 80	121

The average results include bad farmers and bad seasons; the good farmer expects to do considerably

[1] Discourse delivered at the Royal Institution on Friday, February 20.

[2] Unfortunately the terms "bushel" and "quarter" (8 bushels) lack definiteness, being used officially in three different senses and unofficially in several others also. The following are some of the definitions of a bushel:—

	Official Statistics. A definite volume having the following average weight	Corn Returns Act. Volume occupied by following weight	Grain Prices Order. Volume occupied by following weight	Frequent Practice. Volume occupied by following weight
	lb.	lb.	lb.	lb.
Wheat ...	61·9	60	63	63
Barley ...	53·7	50	55	56
Oats ...	39·3	39	42	42

better, but he has many things in his favour: superior knowledge, greater command of capital, and possession of good land; he will, therefore, always stand above the average. Even his results can be improved; the highest recorded yields show what can be done with present varieties and present methods in exceptionally favourable circumstances. The figures give the measure of the scientific problem, which is to discover what changes would be necessary in order to bridge the enormous gap between the average and the best. In three directions progress is possible; we may modify the plant or the soil, or we may mitigate the effects of unfavourable climate.

Before the soil can be brought into cultivation at all it is necessary to carry out certain major operations—draining, enclosing, etc.—which have to be maintained in full order. These lie outside our present discussion; we must assume that they are properly carried out, which is by no means always the case. Given adequate drainage, soil conditions are profoundly modified by cultivation, which has developed into a fine art in England and Scotland, and is, indeed, far better practised here than in most other countries. But it is an art, and not yet a science; the husbandman achieves the results, but no one can yet state in exact terms precisely what has happened. A beginning has been made, and a laboratory for the study of soil physics has been instituted at Rothamsted and placed under Mr. B. A. Keen, where we hope gradually to develop a science of cultivation. For the present cultivation remains an art, and, further, it is essentially a modern art. The medieval implements, as shown in the Tiberius MS. (eleventh century) and the Luttrell Psalter (fourteenth century), were crude, and left the ground in an exceedingly rough condition. Great advances were made throughout the nineteenth century. Robert Ransome, of Ipswich, took out his first patent in 1785 to improve the plough; he was followed in 1812 by Howard, of Bedford, and later by Crosskill, Marshall, Rushton, Fowler, and others, who have made British implement-makers famous throughout the world. Given time and sufficient labour, the good British farmer using modern implements can accomplish wonders in the way of cultivation.

Unfortunately, neither time nor labour is always available. Ploughing is possible only under certain weather conditions, and there are many days in our winters when it cannot be carried out. Unless, therefore, a large staff of men and horses is kept, the work often cannot be done in time to allow of sowing under the best conditions.

The early days of the life of a plant play almost as important a part in its subsequent history as they do in the case of a child. Illustrations are only too numerous of the adverse effect of being just too late for good soil conditions. One from our own fields is as follows:—

Work completed	Seed sown	Yield of wheat 1916. Bushels per acre
Just in time ...	Nov. 24, 1915	26·8
Just too late ...	Feb. 17, 1916	19·3

The farm-horse will not be speeded up, but maintains an even pace of 2½ miles per hour. According to the old ploughman's song still surviving in our villages, an acre a day is the proper rate:—

> We've all ploughed an acre, I'll swear and I'll vow,
> For we're all jolly fellows that follow the plough.

But under modern conditions it is impossible to get more than three-quarters of an acre a day ploughed on heavy land, and the scarcity of teams threatened to bring arable husbandry into a hopeless *impasse*. Fortunately for agriculture, the internal-combustion engine appeared on the farm at a critical moment in the shape of the tractor, and has brought the promise of a way out.

The tractor has two important advantages over the horse. First of all, it works more quickly. Its pace is 3½ miles per hour instead of 2½ miles. It turns three furrows at a time instead of one only; on our land it ploughs an acre in four hours instead of taking nearly a day and a half, as required by horses. There is no limit to the work it can do; even an acre an hour is no wild dream, but may yet be accomplished. It therefore enables the farmer to get well forward with his ploughing during the fine weather in late summer and early autumn, and thus to obtain the great advantages of a partial fallow and of freedom to sow at any desired time. On our own land our experience has been as follows:—

Dates of Completion of Sowings of Wheat and Oats.

Year	Wheat	Oats	
1916	February 17	October 16	Horses only
1917	March 16	,, 17	Horses only
1918	January 26	,, 27	Horses only
1919	November 26	,, 5	Tractor

Further, if the plough is correctly designed and properly used, the tractor does the work fully as well as horses—even the horse-ploughman admits that. It therefore increases considerably the efficiency of the labourer, which, as we shall see later on, might advantageously be raised. The cost of working is apparently less, though it is difficult to decide this until one knows what the repairs bill will be. In our case the cost is:—

Cost of Ploughing per Acre, Autumn, 1919.

	By tractor s. d.	By horses s. d.
Labour	7 7	10 2
Maintenance	—	22 6
Oil and petrol	7 8	—
Depreciation and repairs ...	6 3	—
	21 6	32 8
Time taken ...	4 hours	1½ days

The internal-combustion engine is only just at the beginning of its career on the farm, and no one can yet foresee its developments. It is being used at present simply like a horse, and is attached to implements evolved to suit the horse. But it is not a horse; its proper purpose is to cause rotation while it is being used to pull, and in some cases, indeed, this pull is reconverted into rotary motion.

The second great method of improving soil conditions is to add manures and fertilisers. Farmyard manure is more effective than any other single substance; it is likely to remain the most important manure, and if available in sufficient quantity it would generally meet the case. Realising its importance, Lord Elveden generously provided funds for extended investigations at Rothamsted into the conditions to be observed in making and storing it. This work is still going on, and is leading to some highly important developments.

Farmyard manure, however, is not available in sufficient quantities to meet all requirements. The chemist has long since come to the aid of the farmer; he has discovered the precise substances needed for the nutrition of the plant, and prepared them on a large scale. Like cultivation, this is largely a British development; it was in London that the first artificial manure factory was established in 1842, and for many years the industry was centred in this country. The fertilisers now available are as follows:—

Nitrogenous—Nitrate of soda, nitrate of lime, sulphate of ammonia, and cyanamide (nitrolim).

Phosphatic—Superphosphate, basic slag, mineral phosphate, guano, and bones.

Potassic—Sulphate of potash, muriate of potash, and kainit.

Agricultural chemists have worked out the proper combinations for particular crops, and obtained many striking results.

Without using any farmyard manure they have maintained, and even increased, the yield of corn crops, fodder crops, and hay; and in the two latter cases there has been an increase, not only in yield, but also in feeding value per ton. In spite of seventy years' experience there is still much to be learned about the proper use of artificial fertilisers, and they may still bring about even fuller yields from the land.

The yield of corn crops can be increased by artificial fertilisers, but not indefinitely; the limit is set by the strength of the straw. As the plant becomes bigger and bigger, so the strain on the straw increases, until finally, when the plant is some 5 ft. high, it cannot stand up against the wind, but is blown down.

Little is known about the strength of straw. It is a property inherent in the plant itself, and differs in the different varieties. It is affected by the season, being greater in some years than in others. It is affected also by soil conditions. At present the strength of the straw is the wall against which the agricultural improver is pulled up. The problem can undoubtedly be solved, and the plant-breeder and soil-investigator between them may reasonably hope to find the solution.

Another great effect of artificial fertilisers which has not yet been fully exploited is to mitigate the ill-effects of adverse climatic conditions. Phosphates help to counteract the harmful influence of cold, wet weather; potassic fertilisers help the plant in dry conditions. The combination of a suitable variety with an appropriate scheme of manuring is capable of bringing about considerable improvement in crop production.

A demonstration with the oat crop on these lines was arranged last year in a wet moorland district, and the crops when seen in August were as follows:

	Estimated crop Bushels.	
Local variety, local treatment ...	27	Harvest late
" " phosphatic manuring	45–54	" earlier
Special variety "Yielder," phosphatic manuring	54–66	" earlier, stands up well

The potato crop is governed by the same general principles as corn crops. It furnishes more food per acre than any other crop, but it is much more expensive to produce, and therefore is grown chiefly in districts where the conditions are particularly well suited to it: the Fens, Lincolnshire, the plains of Lancashire, and the Lothians, though smaller quantities are grown in almost every part of the country. The production and consumption are as follows:—

Potatoes: Annual Production and Consumption.

	Production					
	In England and Wales			In United Kingdom		
Consumption	Pre-war 1914	1918	1919	Pre-war 1914	1918	1919
6·5	3·0	4·2	2·7	7·5	9·2	6·3
Millions of acres	0·46	0·63	0·48	1·20	1·51	1·22

We are thus self-supporting in the matter of potatoes. We do, however, import about half a million tons per annum of early and other potatoes; we also export seed potatoes and some for food—in all, about one million tons per annum.

(*To be continued.*)

Notes.

WE regret to announce the death, on April 3, at eighty-four years of age, of Capt. E. W. Creak, C.B., F.R.S., formerly Superintendent of Compasses, Hydrographic Department, Admiralty.

THE following names were inadvertently omitted from the list of Commanders of the Order of the British Empire (C.B.E.) announced in last week's issue of NATURE:—Mr. C. E. Fagan, secretary, British Museum (Natural History); Sir W. H. Hadow, Vice-Chancellor of the University of Sheffield; and Mr. A. R. Hinks, F.R.S., secretary of the Royal Geographical Society.

LORD SUDELEY has given notice of the following motion which he proposes to bring before the House of Lords on April 21:—"To call attention to the decision of his Majesty's Government to discontinue the appointment of an official guide at Kew Royal Botanical Gardens; and to move to resolve, That the Government be requested to carry out at these gardens the system of free popular guide-lectures on the same plan as adopted with marked success in the Government museum and picture galleries of the Metropolis, and to take such further steps as after inquiry may be found desirable for developing the resources of these gardens to the fullest extent in the interests of scientific and popular education, together with the recreation of the public."

THE RIGHT HON. F. D. ACLAND recently asked in the House of Commons whether the Lord President of the Council "is aware that dissatisfaction is being expressed by scientific workers with the appointment of a man without scientific qualifications as director of research to the Glass Research Association; whether, as the Department of Scientific and Industrial Research provides four-fifths of the funds of the association, the Department was consulted before the appointment was made; and does he approve of the appointment as giving a guarantee that State funds devoted to scientific research will be wisely expended?" Mr. Fisher replied to the question, and his answer included the following statements:—(1) The successful candidate has a wide and successful experience of scientific research into the problems of the glass industry, and is considered by the association to be the man best suited for organising and directing the research needed by it. (2) The responsibility for the selection of a director of research rests in each case with the research association concerned, and not with the Department of Scientific and Industrial Research, which has no power to approve or disapprove the appointment of any individual. (3) The Department guarantees three-quarters of the expenditure of the research association up to a certain limit, but payment of the grant is conditional, among other things, on the approval by the Department of the programme of research and of the estimate of expenditure thereon. (4) The Advisory Council of the Department, after considering all the relevant circumstances with great care, recommended the approval of the expenditure involved in this director's appointment.

MR. B. D. PORRITT has been appointed director of research by the Research Association of British Rubber and Tyre Manufacturers.

THE annual meeting of the Iron and Steel Institute will be held at the Institution of Civil Engineers, Westminster, on Thursday and Friday, May 6 and 7, and will be adjourned from May 7 to May 14, when a final session will be held at the Mappin Hall, Sheffield. On the opening day the retiring president, Mr. Eugène Schneider, will induct into the chair the president-elect, Dr. J. E. Stead, the Bessemer gold medal for 1920 will be presented to Mr. Harry Brearley, and the president will deliver his inaugural address. The autumn meeting of the institute will open at Cardiff on September 22.

THE World Trade Club, of San Francisco, which is conducting an active propaganda in favour of the compulsory adoption of the metric system of weights and measures, both in this country and in the United States, has issued under the title "Metric Literature Clues" a list of references to books, pamphlets, documents, and magazine articles on standardisation in terms of metric units. Although far from being a complete bibliography of the metric system, it includes most of the best-known works on the subject, and contains a fairly full list of the publications of the United States Government and of the Bureau of Standards. In some cases the title of a book or article is followed by a brief summary of its contents, sufficient to indicate to those interested in weights and measures whether it is worth while consulting the work in question. This is the most practical and useful publication of the World Trade Club with regard to the metric system that has yet come to our notice.

AT a meeting of the Association of Economic Biologists held on March 24 the following papers were read: (1) Mr. D. W. Cutler, "The Relation of Protozoa to Soil Problems"; (2) Mr. J. F. Martley, "The Resin-Galls of the Wood of the Sitka Spruce (*Picea sitchensis*)"; (3) Dr. W. Lawrence Balls, "The Nature and Scope of Botanical Research in the Cotton Industry"; (4) Dr. M. C. Rayner, "The Calcifuge Habit in Ling (*Calluna vulgaris*) and other Ericaceous Plants"; (5) Dr. H. Wormald, "Shoot Wilt of Plum Trees." Perhaps the outstanding feature of the meeting, emphasised alike in papers and discussion, was the necessity of pure research as a basis for all economic applications of biology. Not only is it impossible to conduct investigations into any applied aspect of a biological problem in which at the same time equal attention is not given to the more fundamental considerations, but more usually it is also not possible to separate the economic from the pure issues. A further point of importance, arising particularly in the discussion on Dr. Balls's paper, is the great shortage in this country of young botanists competent to undertake research on industrial problems. With the expected development of research associations and the partial recognition by manufacturers of the vital place of the botanist in industry, this factor will become increasingly apparent and be a serious menace to progress.

THE Port Erin Biological Station will be occupied during the Easter vacation (March 20 to April 20) by nine or ten professors, each with a group of senior students, including Profs. Doncaster, Harvey-Gibson, Johnstone, and Herdman (Liverpool), Prof. Gamble (Birmingham), Dr. Tattersall (Manchester), Mr. Douglas Laurie (Aberystwyth), Prof. Benjamin Moore (London), Prof. Cole (Reading), Prof. Stephenson (Lahore), and Prof. Dakin (Western Australia). There are also groups of other post-graduate workers and senior students from Cambridge, Nottingham, Liverpool, and other centres, as well as a large botany class in the earlier part of the vacation, to be followed by a zoology class later. The laboratory accommodation is strained to the utmost capacity, and additions to both building and staff are urgently required. The usual excursions for shore-collecting and plankton work and dredging are being arranged, and the fish-hatching is in full swing. The season is an early one at sea. The phyto-plankton has consisted for the last ten days of March mainly of Coscinodiscus and Biddulphia, and the plaice in the spawning-pond have produced fertilised eggs at least a month earlier than usual—the first hatched larvæ were noticed on February 9—and herring are being caught each night in the bay. The Bill transferring the biological station and fish hatchery from the Manx Government to the Oceanography Department of the University of Liverpool has now passed through the House of Keys, and the University takes over the control of the institution and the work as from April 1 last. The director wishes it to be known that this makes no change in the use of the biological station by researchers from other universities.

THE Ministry of Agriculture and Fisheries last year purchased an estate of more than 1500 acres of typical heath-land at Methwold, in Norfolk. This estate is to be a National Demonstration Farm, and one of the chief objects for its existence is to show what can be obtained from poor heath-land by the adoption of good husbandry methods. The Weekly Service for March 20 from the Ministry of Agriculture gives a short account of the work to be undertaken at this farm. Two hundred acres of the estate have been reclaimed from bracken land, so that at the present time 1043 acres are under arable cultivation, 43 acres under grass, and 441 acres are waste heath. The chief part of the scheme will be the building up and improvement of the land by chalking and by the addition of organic matter. Tobacco-growing on a comparatively large scale will also be a feature of the cultivation. By encouraging the growing of this crop the Ministry hope to supplement the experimental work carried out during the past six years by the British Tobacco Growers' Society, Ltd., and also to assist those smallholders in the neighbourhood who may be inclined to try tobacco-growing when there is a central station at hand to supply the necessary information and to provide for the treatment of the crop. The scheme also includes stock-rearing, poultry-keeping, and pig breeding and rearing on the open-air system. The result should prove very valuable both for large-scale farmers and for smallholders, since the

fields are of a good size and well adapted to the use of implements of a large, up-to-date form, while the light and early character of the land should render it specially suitable for small arable dairy holdings.

THE revival of Oriental research is happily marked by the reappearance of Prof. Flinders Petrie's admirable journal, *Ancient Egypt*. Great changes have occurred since the outbreak of hostilities. In Egypt the main actors are gone—Sir Gaston Maspero, his son Jean Maspero, Legrain, and Barsanti. On the English side the losses have been equally severe—Sir A. Ruffer, H. Thompson, I. Dixon, and K. T. Frost, all victims of the war; and at home the early death of Prof. Leonard King has left history and archæology crippled. But, so far as was possible, work has gone on, particularly under the new conditions in Palestine, where a school of archæology, under the superintendence of Prof. Garstang, is being founded. The British School in Egypt is starting work with a large staff, and in the United States, under Prof. Breasted, the Oriental Institute of the Chicago University has been opened. But funds are badly wanted both in Egypt and in Palestine, and though this is an unfavourable time for such an appeal, there is good hope that British archæologists will provide the necessary assistance.

IN the *Museum Journal* (vol. x., No. 3, September, 1919) Mr. H. V. Hall discusses the question of African art. So much has been said, Mr. Hall remarks, about the uniformity of African culture that the variety which exists tends sometimes to be overlooked. The people of eastern and southern Africa are chiefly interested in the products of the animal, those of central and western Africa in the products of the vegetable, kingdom. Speaking broadly, the region east of the lakes and south of the Zambezi-Congo watershed is the home of pastoral tribes, and the Congo and the Lower Niger races practise agriculture. Hence the latter have more leisure to devote to artwork. The question of foreign influence on the negro is of great importance. There are at least four routes from the north and north-west by which the dark heart of the continent can be reached. A growing mass of evidence points to the conclusion that, even in historic times, these routes have never been quite barred to civilising influences; especially in the expansion of old Egypt the solution of many problems of culture apparently indigenous in Central Africa must be sought.

A COMMITTEE appointed by the Royal Anthropological Institute is engaged in collecting information regarding megalithic monuments. As an example of the scientific method of conducting such a survey, Messrs. J. S. Wilson and G. A. Garfitt, in the March issue of *Man*, supply a map of the Eyam Moor circle in Derbyshire. This work is important in connection with Sir Norman Lockyer's investigations. "In the survey of the Eyam Moor circle several large stones were noted on the near horizon towards the N.E. and E. The path of the sun at sunrise for the latitude of the circle, after making allowances for refraction, was calculated for different declinations of the sun and plotted on the chart. It will be seen that the position of prominent stones plotted on the diagram appears to mark the position of sunrise at midsummer and at the equinox. On the diagram the position of sunrise is shown for the present obliquity of the ecliptic, or sun's apparent declination of 23° 27′, also for an obliquity of 23° 57′, which, according to the estimates of astronomers, would have been correct 2000 years before the Christian era. The small difference in the position of the sun indicates the difficulty of fixing the age of a monument by this means."

THE Department of Agriculture, Federated Malay States, in view of the necessity for an increased local production of foodstuffs, has issued a special Bulletin (No. 30) on "Food Production in Malaya," compiled by Mr. F. G. Spring and Mr. J. N. Milsum. The booklet contains 112 pages and 12 plates, costs one dollar, and brings together a large amount of useful information. It includes sections on seasons and rainfall, types of land (whether coastal or inland), soils, tillage, agricultural machinery, rotation of crops, manures, and insect pests and other diseases. Suitable cereal, pulse, and root crops are described, and their cultivation, harvesting, yield, and economic uses considered in some detail. The principal cereals are ragi (*Eleusine coracana*) and rice; various millets and sorghum form subsidiary crops; the chief pulses are green and black gram, cow-pea, and the ground-nut; and the chief root-crops sweet potato, yams, and manihot (tapioca).

A SYSTEMATIC enumeration of the palms of the Philippines is given by Dr. O. Beccari in the *Philippine Journal of Science* (vol. xiv., No. 3). One hundred and twenty species are at present known to be indigenous, which, with the exception of about a dozen species of relatively wide geographic distribution, are endemic forms. In discussing the relationships of the palm-flora, Dr. Beccari concludes that the Philippine species have in great measure originated in the archipelago, but their phylogeny may be traced to species growing chiefly in Borneo, Celebes, the Moluccas, and Indo-China, excluding about a dozen species which, possessing adaptations for easy dissemination, have a rather wide distribution. A small Polynesian element is represented by Adonidia, the only genus peculiar to the archipelago, and Heterospathe. In the Philippines a few large genera have given rise to numerous species, whereas in Polynesia monotypic or oligotypic genera are numerous, and no genus contains a great number of species.

THE *Meteorological Magazine* for March gives a short notice of the work of the International Meteorological Conference held in Paris in October last, taken from the account of the conference published in Paris by the Bureau Central Météorologique. Further details will be welcomed when they are published by the meteorological authorities in our own country. The preceding meeting of the body was held at Innsbruck in 1905, so that much advance in the

science had to be reported and new methods of working arranged for, especially with regard to aviation. The magazine contains a reproduction of a photograph of the members of the conference.

THE Meteorological Office chart of the North Atlantic Ocean for February contains some notes on the origin and distribution of ice in these waters, and some account of the ice patrol of the United States Government which was resumed in 1919 after several years' interruption during the war. Two coastguard cutters have been detailed for the purpose of locating icebergs and pack-ice in the vicinity of trans-Atlantic steamship routes. During the months of April, May, and June the two vessels alternate on patrol, each taking fifteen days in the ice region, exclusive of the time taken in going to and from Boston for coal and supplies. Movements of ice are reported by wireless at fixed hours daily. At 6 p.m. (75th meridian time) ice information is sent broadcast with a 600-metre wave-length. The message is repeated three times. At 6.15 p.m. the same information is sent out, using a 300-metre wave-length. At 4 a.m. a message defining the native and southern limits of the ice is sent to the New York Hydrographic Office. Ice information is also sent at any hour to any ship with which the patrol vessel can communicate. It will be recalled that this is the work which was initiated by the *Scotia* subsequent to the loss of the *Titanic*. The chart also bears an interesting map showing the drifts on the east coast of Greenland, in Baffin Bay, and in Davis Strait of various ships that have been imprisoned in the ice, and of castaway crews during the last hundred years. The March chart gives an account of the relation of the North Atlantic ice to currents and fogs.

CHERRAPUNJI, in the Khasi Hills in India, is often cited as having the greatest known annual rainfall. According to the Indian Meteorological Department, the mean annual rainfall there is 426 in. The greatest precipitation is said to have occurred in 1861, when a rainfall of 905 in. was recorded, though doubt has been expressed as to the accuracy of this record. It appears, however, that the Cherrapunji rainfall is surpassed by records on the mountains in the Hawaian islands. Thus Mount Waialeale is the peak (5080 ft.) of the Island of Kauai, but is inaccessible except to the most expert mountaineers. On this account it was very difficult to maintain the station, and the record has finally had to be discontinued. According to the *Monthly Weather Review* (U.S. Dept. of Agric.), vol. xlvii., No. 5, during the periods August 2, 1911–March 26, 1914 and May 31, 1915–August 13, 1917, a total of 1782 days, there was recorded on Mount Waialeale a total precipitation of 2325 in., or an average of 1·3047 in. per day. In a 365-day year this would amount to an annual precipitation of about 476 in. No records were obtained during the years 1914 and 1918, but these years were considered the wettest since the local Weather Bureau Office was established in the Hawaian islands. Comparative estimates from trustworthy records obtained at near-by stations indicated that the rainfall at Waialeale must have exceeded 600 in. From May 21, 1915–May 30, 1916, the recorded rainfall of Mount Waialeale was 561 in. The Hawaian islands are known for other very damp spots. Thus Puu Kukui, 5000 ft., on the Island of Maui, had a seven-year average of 369 in. (maximum 562 in. in 1918). On the Island of Hawaii, at a certain spot of 4000-ft. elevation, the rainfall in 1914 amounted to 504 in. At at least a dozen other spots, all more than 1000-ft. elevation, the rainfall in each of the years 1914 and 1918 exceeded 350 in.

TECHNOLOGIC Paper No. 123, by Mr. D. W. Kessler, of the Bureau of Standards, Washington, is devoted to the tests of the physical and chemical properties of fifty of the commercial marbles of the United States. Marble has been selected as the first stone to be tested, but the whole of the deposits of stone in the country are to come under test in course of time in order to provide the knowledge required by architects in designing structures. The tests are of tensile and compression strengths, specific gravity, porosity, absorption of water, effect of freezing, chemical composition, electrical resistivity, expansion with heat, and liability to warping. The trade name and origin of each sample are given, and the tabulated results of the tests fill twenty pages. The properties of the samples differ widely, although the specific gravities do not differ more than about 5 per cent. from each other. On heating, each sample expands, and on afterwards cooling fails to regain its original dimensions. In consequence of this, marble subjected to frequent heating and cooling is liable to warp.

SCIENTIFIC Paper 352 of the Bureau of Standards, Washington, gives the results of the measurements of the expansion of forty samples of porcelain, about the same number of samples of bakelite and similar materials, and about a dozen samples of marble and limestone, made by Messrs. W. H. Souder and P. Hidnert, of the Bureau. The samples were in the form of rods 30 cm. long and 1 cm. square section, and were heated in a horizontal electric furnace. The expansions were measured by a pair of microscopes mounted on a bar of invar. For the porcelain samples the coefficients per degree Centigrade between 0° C. and 200° C. vary from 2 to 20 millionths, according to the composition, and between 200° C. and 400° C. from 3 to 11 millionths. Beryl porcelains have the smallest coefficients. For bakelite and similar materials no values can be given, as there is so much contraction on again bringing the material to its original temperature. The marbles up to 100° C. have coefficients between 5 and 15×10^{-4}, and at higher temperatures larger values. On cooling to their original temperature they show a permanent expansion. When cooled to −80° C. marble expands to nearly the same extent as when heated to 80° C., so that it has its maximum density in the neighbourhood of 0° C.

THE Science Reports of the University of Sendai, Japan, for December, 1919, contain a paper by Mr. S. Konno on the heat conductivities of metals below and above their melting points. The metals were tested in

the form of circular discs about 2 cm. thick and 2·5 cm. in diameter enclosed in a porcelain tube between iron cylinders of the same diameter. In the upper iron cylinder heat was generated by a measured electric current. The fall of temperature through the disc was determined by means of thermo-couples. For tin, lead, zinc, and aluminium the heat conductivity decreases gradually up to the melting point. At the melting point the conductivity decreases abruptly, but in the liquid state its rate of decrease with increase of temperature is slight. Bismuth increases in conductivity on melting, but change of temperature has little effect on the conductivity in either the liquid or the solid state. Antimony has its maximum conductivity at the melting point. In all cases the electrical and heat conductivities change in the same direction on melting, but neither above nor below the melting point does their quotient agree with electronic theories.

THE trouble of working gelatine plates under tropical conditions seems at last to have been overcome. In the Journal of the Royal Photographic Society for March, Mr. A. P. Agnew, of Messrs. Ilford, Ltd., describes the "Ilford tropical hardener" that is now supplied by Messrs. Johnson and Sons. Mr. Agnew found that a "quite weak solution of formalin" became very effective when certain salts were dissolved in the solution. Many sodium salts were found useful, while potassium and magnesium salts are not so effective, and ammonium salts are unsuitable. Some salts have no effect, while chlorides, bromides, and nitrates in general have an opposite action—that is, they soften the gelatine. The exposed plate is put into the suitably diluted hardening solution for three minutes, then rinsed and developed, etc., as usual. Plates so treated at temperatures varying from 100° to more than 140° F., then fixed in a plain hypo solution at 40° F., and finally washed for two hours at more than 100° F. remained firm and did not even show signs of reticulation. Such trying conditions as these would never occur in practical work.

A PHOTOGRAPHIC developing agent must be able to reduce silver bromide that has been changed into the developable condition, as by exposure to light, while under the same conditions it is unable to reduce silver bromide that has not been so changed. There are many reducing agents that make no distinction between these two states of silver bromide. Some twenty years ago Messrs. A. and L. Lumière found certain details of chemical constitution that appear to confer developing power, and since then they and others have extended the investigation. In the *British Journal of Photography* for March 26 there appears a translation of a paper by Dr. Seyewetz (of Lumière's) in which the author summarises our present knowledge of this matter. Knowing the necessary constitution, a very large number of developers have been introduced and actually put upon the market, but the greater number have commercially disappeared, because in some way or other they were inconvenient to use. Dr. Seyewetz says that it is improbable that new developers will displace those now in common use. As in the case of dyes, it seems difficult to make sensational discoveries, and there is so far no indication of the direction in which to seek for new developers that would prove acceptable, as, for example, by permitting a reduction in the period of exposure.

BESIDES the paper on H.M.S. *Hood*, read at the recent meeting of the Institution of Naval Architects by Sir Eustace d'Eyncourt, there are important articles in the *Engineer* and *Engineering* for March 26 dealing with this ship. The building was commenced in April, 1916, at the Clydebank yard of Messrs. John Brown and Co., Ltd., the first of the main belt armour-plates (32 tons each) reached the yard in June, 1918, the ship was launched on August 22, 1918, and the fitting out was completed in January of this year, when the huge ship passed down the Clyde to the open sea. On the trial trips the turbines developed 157,000 shaft-horse-power, the speed attained being 32 knots. The overall length is 860 ft., the extreme breadth 104 ft., the mean load draught 28·5 ft., and the displacement at load draught 41,200 tons. The hull is fitted with a bulge or blister for securing the ship against effective attack by torpedo. The armour ranges from 12 in. thick amidships to 5 in. aft. The deck over the magazines is 3 in. thick. There are eight 15-in. guns, all on the middle line, each pair being mounted in an armoured barbette. The secondary armament consists of twelve 5·5-in. guns, and there are four 4-in. anti-aircraft guns mounted on the superstructure. The ship is fitted with six torpedo tubes for 21-in. torpedoes. There are eight electric generators, four of which are driven by reciprocating engines, two by geared high-speed impulse turbines, and two by eight-cylinder Diesel oil engines. About 360 electromotors are installed, ranging from ¼ to 140 brake-horse-power.

SIR ALFRED EWING is bringing out almost immediately, through the Cambridge University Press, a treatise on "Thermodynamics for Engineers," in which the author aims at making readers familiar with the physical bearing of the fundamental ideas of the subject by means of an elementary introduction and by dealing with practical problems in the theory of heat-engines and of refrigeration. A more mathematical treatment of general thermodynamic relations follows. There will also be an appendix sketching in outline the molecular theory of gases, with special reference to internal energy and specific heat. Another book on the list of the Cambridge University Press is by Prof. A. S. Eddington, entitled "Space, Time, and Gravitation." It is promised for the coming summer.

A FORTHCOMING addition to Sir Edward Thorpe's series of Monographs on Industrial Chemistry is of current interest, seeing that it will treat of "The Manufacture of Sugar from the Cane and Beet." It will be by T. H. P. Heriot, of the Royal Technical College, Glasgow, and give special attention to the principles underlying factory operations.

ERRATUM.—On p. 138 of NATURE of April 1, col. 1, line 15 from the bottom of the page, bx should be $bx^{\frac{1}{2}}$ in the equation $y=ax^{\frac{1}{2}}+bx^{\frac{1}{2}}$. The fractional index was broken during paging of the issue.

Our Astronomical Column.

CAPELLA.—A knowledge of the parallax of Capella is of special interest owing to the close resemblance of this star's spectrum to that of the sun and the fact that it is a spectroscopic binary with a period of 104$\frac{1}{2}$ days. Prof. F. Schlesinger and Mr. Z. Daniel have made a new determination at the Allegheny Observatory (*Astr. Journ.*, No. 765). They observed both the principal star and Furuhjelm's distant companion. The weighted mean parallax (absolute) is 0·068″ ± 0·006″. Earlier results are: Elkin, 0·079″; Jost, 0·051″; and Adams and Joy, 0·105″.

The star B.D.+61° 2068, the proper motion of which is 0·77″, was also measured for parallax at Allegheny, the large value 0·139″ ± 0·007″ (absolute) being found. The corresponding absolute magnitude is 9·3 visual and 10·5 photographic.

Attempts were made some twenty years ago to detect the duplicity of Capella telescopically. It was considered for a time that the 28-in. equatorial at Greenwich gave an elongated image, but, in view of the failure of the great American refractors, little reliance was placed on this. A letter from Prof. Hale dated January 6 last (*Observatory*, March) announces that success has been obtained by interferometer methods with the 100-in. reflector. It was deduced that the separation on December 30, 1919, was 0·042″, and the position angle 148° or 328°. It is hoped that a continued series of such observations will give a determination of the inclination of the orbit, and hence of the masses of the components. There is even a prospect that the diameters of such giant stars as Sirius, Antares, and Betelgeux may be determinable with the interferometer.

CAPE OBSERVATIONS OF THE SUN, MERCURY, AND VENUS.—The Cape observations of these bodies, made with the new transit circle and the travelling-wire micrometer during the five years 1907–11, have just been distributed, together with a discussion of results. The corrections to the equinox derived from the three bodies are in good accord, and indicate that Newcomb's system of right ascensions needs the constant correction −0·05s. The corrections to Newcomb's longitudes of perihelia of Mercury, Venus, and the earth are −0·78″, +6·8″, and −7·4″ respectively. These are of interest in relation to the Einstein controversy. Newcomb applied the corrections to the centennial motion of the perihelia given by the Asaph Hall hypothesis, according to which gravitation varies as $r^{-2.0000001612}$. This formula gives +43·37″, +16·98″, and +10·45″ for Mercury, Venus, and the earth, whereas Einstein's formula gives +42·9″, +8·6″, and +3·8″. It will be seen that the adoption of Einstein's law of gravitation by the Nautical Almanac would mean a movement towards Newton's law, not a departure from it.

The following semi-diameters of Mercury and Venus at distance unity were deduced from the observations:—Mercury (latitude observations) 3·36″ ± 0·03″, (longitude) 3·79″ ± 0·17″; Venus (latitude) 8·67″ ± 0·03″, (longitude) 8·07″ ± 0·04″. The tabular values are 3·34″ and 8·40″. As these depend to a considerable extent on observations made during transits, they are likely to be somewhat too small.

The Cape results may be too large owing to irradiation, but, since all the observations were made in daylight, this is not likely to be excessive. But as the mass of Venus is only five-sixths that of the earth, it is probable that its diameter is also smaller, whereas the Cape figures make it equal to the earth.

Basic Slag and its Uses in Agriculture.

AN important discussion on basic slag and its uses in agriculture, organised by the Faraday Society, at which a number of leading representatives of the steel makers and of agriculturists were present, was held in the rooms of the Chemical Society on March 23. Prof. F. G. Donnan presided over the meeting.

The discussion was opened by Dr. E. J. Russell, who gave a general survey of the subject and indicated the nature of the problems concerned. The basic slag produced by the basic Bessemer process had earned a high reputation as a potent agent in the improvement of poor pastures. The effect is indirect, and results from a stimulation of the white clover—whether the action of the phosphate is on the clover plant or on the nodule organism is not yet certain. But whatever the reason, the effect on pasture land is very marked, and British agriculturists could absorb some 300,000 or 400,000 tons a year if this could be produced. Unfortunately for agriculturists, however, the Bessemer process is in danger of supersession, and the basic open-hearth process is taking its place. This new process gives two kinds of slag, both poorer than the Bessemer slag in phosphates.

One of these slags is made by the use of calcium fluoride, and in consequence is less soluble than the other. The great problem before the investigator at the present time is to enrich the low-grade slags so as to make them better worth grinding and transport than they now are.

Open-hearth slag made without fluorspar has hitherto proved practically as effective as the old Bessemer slag when compared on the basis of equal amounts of phosphorus. Fluorspar slag has proved to be of less value, although considerably better than was at first thought.

It is usually assumed, though by no means proved, that the phosphate is the only effective constituent in the slag. At various times it has been suggested that lime, manganese, or iron might be useful; it is also possible that slag contains a silico-phosphate which might have more value than the ordinary phosphate.

The enrichment of the slag cannot apparently be brought about by any change in the pig iron, owing to the great disparity in price between steel and slag; fractionation is, however, possible, or the addition of ground mineral phosphate to the molten slag. Further experiments would be necessary before any decision can be made.

Sir Thomas Middleton gave an account of the place of basic slag in the agricultural system of this country. British farmers tend more and more to produce animal rather than human food. The two main human food-crops—wheat and potatoes—occupied no more than 3,000,000 acres before the war, while 36,000,000 acres were devoted to the crop requirements of cattle and sheep. The value of the wheat and potatoes was about 27,000,000*l.*, while the live stock brought in some 125,000,000*l.* The supreme importance of basic slag arises from the fact that it helps to produce animal food; it is essentially a pasture fertiliser. In the Cockle Park experiments the untreated pasture yielded about 20 lb. of lean meat per acre per annum; after treatment with basic slag the yield rose to 105 lb. of meat per acre. The results of many other experiments show that on thousands of acres in this country the yield of meat might be increased by the use of basic slag. Nor are the advantages of slag confined to grass land. By ploughing up more grass, valuable additions could be made to the tillage land, and if the remaining grass were treated with basic slag there

would be no falling off in total yield, in spite of the diminished area.

Mr. Bainbridge gave an account of the experiments by Dr. Stead and Mr. Jackson on the solubility of basic slag in citric and carbonic acids. The reason why fluorspar makes the phosphoric acid in slag insoluble is that a reaction occurs between fluoride and phosphate, producing an artificial apatite, which, as regards insolubility, resembles natural fluorapatite. Even the most soluble phosphatic slags undergo this change and become insoluble on melting with fluorspar. Carbonic acid, after long-continued attack, generally dissolves out more phosphoric acid than a single attack by the standard citric acid.

Mr. G. Scott Robertson gave details of the field tests made to compare the effect of various types of open-hearth basic slags on grassland. These experiments were made in Essex on London clay, Boulder clay, and chalk. They show that all the phosphatic slags are effective fertilisers; but there are important differences in the agricultural effects, which are not connected with solubility according to the citric acid test; indeed, this test affords no indication of the fertilising value of open-hearth slags. Details of the botanical examination of the plots showed the striking effect of the basic slags in reducing the amount of bare space and in increasing the amount of clover.

Mr. Daniel Sillars made an important contribution from the metallurgical side, discussing the formation of basic slag in the manufacture of steel. The phosphide of iron, Fe_2P, in which state of combination phosphorus exists in molten iron, is oxidised by reactions of the type—

$$5Fe_3O_4+2P=15FeO+P_2O_5$$
$$5Fe_3O_4+8P=15Fe+4P_2O_5.$$

The P_2O_5 formed may combine with FeO to form $Fe_3(PO_4)_2$, which, however, is unstable in the presence of a large excess of iron, and a reaction such as $Fe_3(PO_4)_2+11Fe=8FeO+2Fe_3P$ results, and it is in consequence of this reaction that the acid process of steel-making is unable to remove phosphorus. In the basic process the presence of lime affords an opportunity to the phosphoric acid to form a stable body by the reaction—

$$Fe_3(PO_4)_2+4CaO=Ca_4P_2O_9+3FeO.$$

The calcium phosphate formed is only feebly attacked and decomposed by the metallic iron, but manganese and carbon attack it more vigorously and cause the phosphoric acid to be reduced and the metal to be re-phosphorised. These reactions are, of course, proceeding concurrently, and it is necessary to maintain a certain concentration of ferrous oxide in the slag to minimise, so far as possible, the tendency to re-phosphorisation. Re-phosphorisation is probably due to the reaction between ferrous phosphate and lime being slightly reversible, whereby a small concentration of ferrous phosphate is always present, which is reduced by the carbon unless a source of oxygen is supplied by ferrous oxide in the slag.

In ordinary practice the open-hearth process is carried out by allowing the slag formed by the oxidation of the silicon, phosphorus, and manganese to flow over shutes made in the fore-plates into slag-pots under the furnaces, and no attempt is usually made to remove more slag than that which flows out naturally when the level of the slag in the furnace is higher than the level of the fore-plate. The slag left behind is carried on, and forms part of the finishing slag, which latter is therefore much greater in volume, and therefore lower in phosphoric acid, than the slag removed in the middle of the process. By this method of operation the time spent in tapping the furnace for separation of the slag and for the formation of a new slag is saved, but the slag is inferior both in richness and in citrate solubility if that still forms a criterion of excellence to the agriculturist.

Mr. Ridsdale took part in the discussion, and exhibited specimens of slags examined in the classic investigations by Stead and Ridsdale; and Mr. W. S. Jones contributed a paper on the improvement of low-grade basic slags.

As a result of the discussion it was decided to ask the Ministry of Agriculture to form a Committee which should study possible practical steps to effect improvement in quality and in quantity of the phosphatic slags.

Verification of Screw Gauges for Munitions of War.

THE *Bulletin de la Société d'Encouragement pour l'Industrie Nationale* (November–December, 1919, No. 6) contains an article by M. Cellerier, of the Conservatoire des Arts et Métiers, on the verification of screw gauges, with particular reference to the methods advocated by Mr. Bingham Powell, who was engaged in the United States during the war as Inspector of Gauges and Standards for the British Ministry of Munitions. These methods related chiefly to the measurement of the full, effective, and core diameters; the verification of pitch was neglected until quite a late period of the war, owing to the lack of instruments possessing the requisite precision and rapidity.

Extreme accuracy is of the highest importance in measurements of pitch, as any error in the pitch makes it necessary for the maximum limit of effective diameter to be reduced by double the amount of this error if the gauge is to be accepted as correct. Where the permissible deviations are very small, an error in pitch of a few ten-thousandths of an inch may thus completely annihilate the tolerance on effective diameter. Inaccuracies of pitch are often regarded as essentially progressive; but this is not always the case, as deformations due to hardening may introduce variable errors of quite appreciable magnitude. The method frequently adopted of verifying the pitch by measurements made on a length comprising a number of threads is accordingly much less trustworthy than the practice, long in vogue in France, of testing separately a number of consecutive threads.

For the latter process measuring machines of the pattern used at the National Physical Laboratory are particularly suitable, but at the time when the demand for extreme accuracy in screw gauges for war-work first became pressing it was impossible to obtain one of these machines in America without considerable delay, and accordingly Mr. Powell found it necessary to devise an instrument on the spot. He dispensed with the optical contrivance which forms an essential feature of the laboratory machine, and substituted for the spherical contacts a lever terminating in a small sphere which rests freely in the screw and can be guided conveniently in the axial plane from one thread to another. The lever consists of a very light needle, arranged in such a way that the apparatus can also be used for testing internal screws or nuts by means of appropriate casts taken by an ingenious and delicate method, but only a small segment of the internal thread can be obtained in this way for testing purposes.

As regards the measurement of diameters, although an ordinary micrometer will suffice for the external dimension, it is not suitable for determining either the effective or the core diameter. Before testing the effective diameters it is necessary to know the errors of the pitch, in order that the appropriate reductions may be made in the maximum limit of tolerance. A micrometer with point contacts should never be used alone for the effective diameter, as it bears only on projecting parts, and, further, the points wear down quickly. Even when new, its contacts for screw-threads rarely have the correct angle. It is, however, a useful check on results obtained by the aid of wire contacts, especially for investigating anomalies which may be apparent in these results.

Mr. Powell has made a special study of wire contacts for testing effective diameters. He employs systematically two series of wires for each pitch of screw. One series is such that the wire bears exactly on the theoretical effective diameter of a perfect screw; in the other series the wire bears on the sides of the screw not far from the outer edge, but so as to avoid the rounded-off part in Whitworth threads. The correct diameters for the series are calculated from a simple formula. The wires, which are finished by grinding, must be perfectly cylindrical, and their diameters have to be ascertained to an accuracy of 0·00001 in.; any error in the diameter of the wire is multiplied threefold in the result obtained for the effective diameter. They are made of hardened steel, and are about 2 in. in length, or longer for very large screws; but their exact adjustment is only necessary over about half an inch in the centre of the length.

The verification of internal screws may be effected simply by employing either an external screw having the correct dimensions for external, effective, and core diameters, or a screw correct for maximum and effective diameters, but slightly small for core diameter. A plug is also used in this case for verifying the minimum diameter of the internal screw. If these gauges enter the nut, the test is regarded as satisfactory; but, in reality, this is not always the case, as the external screw may appear to give a good result even if it bears on only one diameter of the nut; while the other diameters may be far outside the limit of tolerance. A large number of different gauges are necessary in order to verify separately every diameter of an internal screw.

Mr. Powell has drawn up a list of equipment required in the verification of screw gauges. This includes a pitch-measuring machine, an apparatus for obtaining casts of internal screws, a projecting arrangement, an instrument for measuring the three characteristic diameters of external screws, a collection of suitable wire contacts, small triangular prisms for verifying core diameters, standardised micrometers, Johansson gauges, and a complete set of standards for measuring diameters, pitch, and form of internal threads.

A theoretical explanation of the principles of the methods employed would have been of interest. In its absence some doubts arise, for example, as to the practical value of profiles of screw-threads projected on screens. Again, the contacts of small cylindrical wires on the helicoidal surfaces of threads cannot be regarded as the same as that of a circle and two intersecting straight lines, although the formulæ employed, which are stated without proof, appear to be founded on a consideration of this kind. In conclusion, Mr. Powell's methods are by no means entirely novel, but they were very successful during the war, and will no doubt be found instructive by all those engaged in the manufacture and verification of screw gauges.

The Composition of Salvarsan.

WHEN salvarsan was first introduced for use in medicine the German manufacturers stated that it contained "about 34 per cent. of arsenic," which is the percentage calculated for a pure dihydroxydiaminoarsenobenzene dihydrochloride, $C_{12}H_{12}O_2N_2As_2,2HCl$. This statement was afterwards altered to "the arsenic content of the preparation corresponds to the formula $C_{12}H_{12}O_2N_2As_2,2HCl,2H_2O$ as a result of Gaebel's observation that the drug loses 7·6 per cent. by weight on drying, and contains only 31·5 per cent. of arsenic." Last year Kober, in the United States, ventured the opinion that the combined solvent in salvarsan is not water, but methyl alcohol, and suggested that the latter might be the cause of variable toxicity in salvarsan—a suggestion which is rather far-fetched in view of the fact that, even on Kober's assumption, a maximum normal dose of salvarsan could contain only 0·04 gram of methyl alcohol.

This and other questions connected with the composition of salvarsan have been investigated in the Wellcome Chemical Research Laboratories, and in a paper contributed to the meeting of the Chemical Society on March 18 Messrs. Fargher and Pyman showed that the combined solvent in salvarsan is water; and though small quantities of methyl alcohol may also be present, due to the use of this alcohol in the liquid from which the drug is precipitated, the amount never exceeds 1·4 per cent., and is frequently *nil*. It was also found that the sulphur always present in commercial salvarsan as a result of the use of sodium hyposulphite as a reducing agent in its preparation, occurs in at least two forms: (1) as a sulphaminic acid, probably "salvarsan" monosulphaminic acid hydrochloride, and (2) attached directly to arsenic; whilst a third portion may be in physical association with salvarsan, which has certain colloidal properties.

These results support the conclusion expressed in the recent Special Report (No. 44) of the Medical Research Committee, that though salvarsan is not a chemically pure substance, there is no known chemical impurity with the presence or proportion of which its varying toxicity can be brought into relation. In this connection it is interesting to note that a specially pure salvarsan free from sulphur, prepared by Messrs. Fargher and Pyman, was tested by the Medical Research Committee and shown to be more than normally toxic. Chemical testing alone is, therefore, insufficient to determine whether any particular batch of salvarsan is suitable for medical use, and it is on this account that the Medical Research Committee has elaborated the system of biological testing, described in the Special Report already referred to, to control the issue of salvarsan in this country. It is satisfactory that the Committee is able to report that, from the point of view of permanence of effect, the British and French salvarsan preparations are therapeutically as good as the German.

University and Educational Intelligence.

THE governors of the Huddersfield Technical College have received a gift of 2000*l*. from Mrs. Mary Blamires, widow of Alderman Joseph Blamires, in memory of her late husband, himself a former student, and afterwards a governor, of the college. The scholarship is to be used for the promotion of research in chemistry.

THE headquarters of the Yorkshire Summer School of Geography, now being organised by the University of Leeds, will this year be the County School, Whitby,

the school buildings having been kindly lent by the governors for this purpose. The object of the Summer School is to provide theoretical and practical instruction in the methods of geography and to furnish opportunities for the discussion and elucidation of problems connected with the teaching of the subject. The course will consist of lectures, laboratory work, field work, and demonstrations. Lectures will begin on Morning morning, August 2, and the course will end on Saturday, August 21. Among the lecturers will be Prof. Kendall (professor of geology in the University of Leeds), Dr. A. Gilligan (lecturer in economic geology), Mr. C. B. Fawcett (lecturer in geography), Dr. W. G. Smith (lecturer in agricultural botany at the Edinburgh and East of Scotland Institute), and Mr. W. P. Welpton (lecturer in education and master of method in the University of Leeds). Applications for tickets should be made to the Secretary of the Yorkshire Summer School of Geography, The University, Leeds.

BEDFORD College for Women, a constituent college of the University of London, and the largest and oldest university college for women in England, has issued an appeal for funds. At the moment, when there is an overwhelming demand by women for higher education and training, the college must either refuse admission to highly suitable students and starve or close down certain departments, or it must enlarge its buildings and increase its endowments. Seven hundred students now crowd into buildings adapted for four hundred and fifty, with the result that in many cases classes have to be triplicated and class-rooms and apparatus shared between different departments. A sum of 100,000*l.* is needed for additional lecture-rooms and laboratories. A second 100,000*l.* is required for endowment, notably for scholarships, the various departments of science, the department of social studies, and the training department. A third 100,000*l.* is badly needed for a hostel. An opportunity for acquiring an admirable site just outside Regent's Park has presented itself. Whether the college can take advantage of this must depend on the generosity of the public. It should, perhaps, be emphasised that, apart from such developments, the income of the college is by no means sufficient for its present needs in view of the enormously increased cost of maintenance and the necessity for raising all salaries. The work of universities in the past could never have been done had there not lived generous men and women who believed they could render no greater public service than by endowing colleges and thus furnishing opportunities for rich and poor to acquire sound learning. May we hope that a like generosity and a like belief exists to-day? The Queen's interest in the college is well known, and has taken the practical form of giving a donation. Subscriptions should be sent to Viscountess Elveden, hon. treasurer of the Bedford College Endowment and Extension Fund, Bedford College, Regent's Park, N.W.1.

Societies and Academies.

LONDON.

Royal Society, March 18.—Sir J. J. Thomson, president, in the chair.—W. B. **Brierley**: A form of *Botrytis cinerea* with colourless sclerotia. A form of *Botrytis cinerea* with colourless sclerotia is described. This was obtained by the isolation and growth of a colourless sclerotium, which was formed in a culture of a normal strain derived from a single spore. The primary origin of the change resulting in the albino form is located in the hyphal mother-cell from which the initial colourless sclerotium arose. Lotsy's dictum that "certainty of purity is a *conditio sine qua non* to obtain proof of the existence of mutation in living beings" is accepted, and it is shown that such a state is possibly not realisable in the fungi. It is suggested that somatic fusions resulting in a change of genotypic values are the mechanism whereby evolution in the fungi has taken place.—R. R. **Gates**: A preliminary account of the meiotic phenomena in the pollen mother-cells and tapetum of lettuce (*Lactuca sativa*). In a preliminary study of meiosis in the pollen development of lettuce, several points have appeared which have a general bearing on cytological conceptions and the problems of genetics. The exceptional condition has been found in lettuce, in which every intergrade occurs between pollen mother-cells and tapetal cells. Even synapsis has been observed in binucleate tapetal cells, which emphasises the physiological aspects of the synaptic contraction. The tapetal cells are peculiar in being often very much elongated and lying lengthwise of the anther. Ultimately they break down and form a plasmodium surrounding the pollen-grains. Cytomyxis also occurs, though rarely, during the stage of synapsis in the pollen mother-cells.

March 25.—Sir J. J. Thomson, president, in the chair.—A. R. **Forsyth**: Note on the central differential equation in the relativity theory of gravitation. The critical equation in Prof. Einstein's theory is—

$$\left(\frac{du}{d\phi}\right)^2 + u^2 = \frac{c^2-1}{\lambda^2} + 2\frac{m}{\lambda^2}u + 2mu^3,$$

so that

$$\left(\frac{du}{d\phi}\right)^2 = 2m\,(u-\alpha)\,(u-\beta)\,(u-\gamma),$$

where α, β, γ are proved to be real and positive for the known planetary bodies in the solar system, and are arranged so that $\alpha > \beta > \gamma$.

There is no need for initial approximation. The equation can be integrated exactly, in terms of elliptic functions. The integral is—

$$u = \gamma + (\beta-\gamma)\,\frac{1+cn\,\{(\phi-\varpi)/\rho\}}{1+dn\,\{(\phi-\varpi)/\rho\}}$$

where $\phi = \varpi$ at perihelion; the modulus of the elliptic functions is given by—

$$k^2 = \frac{\beta-\gamma}{\alpha-\gamma} \text{ and } \rho = \{2m\,(\alpha-\gamma)\}^{-\frac{1}{2}}.$$

Further, the advance of the perihelion in one revolution is—

$$4\rho K - 2\pi,$$

where K is the complete first elliptic integral with the modulus k. These expressions are accurate (and not approximate) in relation to the initial equation. For approximations in connection with the known members of the solar system, k^2 is small, so that K is slightly greater than $\frac{1}{2}\pi$, and ρ is slightly greater than unity. The advance of the perihelion is $2\pi.3m^2/\lambda^2$; and the value of u is—

$$\frac{m}{\lambda^2}\{1 + e\cos(\phi-\varpi) + \frac{m^2}{\lambda^2}e^2\sin^2(\phi-\varpi) + 3\frac{m^2}{\lambda^2}e\,(\phi-\varpi)\sin(\phi-\omega)\}.$$

—R. D. **Oldham**: The frequency of earthquakes in Italy in the years 1896 to 1914. The paper is an attempt to discover whether there is any variation in the frequency of earthquakes which can be attributed to the stresses set up by the gravitational attraction of the sun and the moon. In addition to some small and more or less doubtful variations, there was found to be a very marked maximum frequency about the time of the new moon, when the declinations of the sun and moon were of the same sign and at the full

when they were opposite, together with an equally marked minimum frequency at the full when the declinations were the same, and at the new when they were opposite. At the quarters the frequency is about average; at the times of minimum the frequency is about one-third, and at the maximum about five-thirds, of the average. The magnitude, no less than the fact that it is continuously recognisable throughout the record, shows that the variation is a real one, and it is difficult to find any other cause than the effect of the stresses set up by the gravitational attraction of the sun and the moon.—A. F. **Dufton**: A new apparatus for drawing conic curves. With the apparatus described in this paper the conic is drawn as the polar reciprocal of a circle. A four-bar linkage constrains a pen to trace the locus of the pole of a fixed straight line enveloping a circle upon paper pinned to a rotating drawing-board. The instrument draws conics with precision. It traces the curves at one sweep, and is applicable to all conics.—Capt. J. W. **Bispham**: An experimental determination of the distribution of the partial correlation coefficient in samples of 30. The distributions are described of the observed values of the partial and total correlations from 1000 samples of 30 each. The three attributes of the sampled (artificial) population are uncorrelated, so that observed values of the correlations are departures from the true value, which is zero in each case. The three groups of 1000 total correlations observed are shown to be nearly Gaussian in form, and to be in very close accord with the distributions predicted in general form by R. A. Fisher, and evaluated in detail in an important co-operative study described in *Biometrika*. The distribution of partial correlations is compared with the Gaussian, the Pearson Type II., and the theoretical distribution of *total* correlations referred to above. It is found to be closely fitted by the latter, and not to show significantly higher dispersion than is indicated by the usual expression for the standard deviation of total correlations, viz. $1-\rho^2/\sqrt{n-1}$. Some important practical bearings of the result are indicated.

PARIS.

Academy of Sciences, March 1.—M. Henri Deslandres in the chair.—G. **Humbert**: The number of classes of positive quadratic forms of Hermite, of given discriminant, in an imaginary quadratic body.—Em. **Bourquelot** and M. **Bridel**: A new glucoside capable of hydrolysis by emulsin, scabiosine. This glucoside was extracted from the root of *Scabiosa succisa* (devil's bit scabious). Details of its isolation and hydrolysis by dilute sulphuric acid and by emulsin are given.—A. **Rateau**: The flight altitude which corresponds to a minimum consumption of petrol per kilometre, and the calculation of the best propeller for a given aeroplane.—A. **Righi**: The experimental bases of the theory of relativity.—A. Mesnager was elected a member of the section of mechanics in succession to the late Marcel Deprez, and A. Fowler a correspondant for the section of astronomy in succession to the late Edmund Weiss.—N. E. **Nörlund**: The convergence of certain series.—A. **Rosenblatt**: A theorem of A. Liapounoff.—M. T. **Huber**: A rational theory of pugging in reinforced concrete, considered as thin plates.—Ch. **Fremont**: The resistance of steels to cutting by tools. It is well known that steels possessing the same resistance to fracture by tension may differ greatly in the ease with which they can be cut by tools. Instead of the usual calculation, maximum load divided by initial cross-section, the author proposes the term "final resistance," obtained by dividing the maximum load by the actual cross-section of the broken test piece.—J. **Guyot** and L. J. **Simon**: The combustion of methyl esters with a mixture of sulphuric and chromic acids. Analytical figures are given for the wet combustion of sixteen methyl compounds of different types, and the carbon dioxide produced is shown to be practically theoretical.—A. **Mailhe** and F. **de Godon**: The preparation of fatty acids by the catalytic oxidation of the primary alcohols. With reduced copper as catalyst, and at temperatures between 260° C. and 270° C., the primary alcohols with air give substantial yields of the corresponding acids. Aldehydes are always produced at the same time, and in some cases more aldehyde than acid is produced.—C. **Schlumberger**: Attempts at the electrical prospecting of the subsoil.—Mme. Z. **Gruzewska**: Contribution to the study of laminarine from *Laminaria flexicaulis*. Laminarine cannot be considered as belonging to the dextrin group, having regard to its lævorotatory power and its resistance to the action of acids and alkalis. Its digestibility by the plant diastases shows it to be a reserve material in the marine algæ.—A. **Sartory**: A new fungus of the genus Aspergillus isolated from a case of onychomycosis.—H. **Piéron**: The variation of energy as a function of the time of stimulation for foveal vision.—A. **Vernes** and R. **Douris**: The action of certain precipitates on the solution of the red blood corpuscles.—R. **Anthony**: The exorchidia of Mesoplodon and the re-ascent of the testicles in the course of the phylogeny of the Cetaceans.—J. L. **Lichtenstein**: The parasitism of *Aphiochaeta* (*Phora*) *fasciata*.—E. F. **Galiano**: Some histological details of the arterial heart of *Sepia officinalis*.—G. **Riquoir**: Colloidal complexes and sera. A preliminary injection of a colloid, followed after an interval by an injection of a curative serum, may produce beneficial effects in cases where the serum injection alone has proved to be without effect. Several examples are detailed.—A. **Trillat**: The influence of the variation of the barometric pressure on the microbial droplets in suspension in the atmosphere.

Books Received.

A Geographical Bibliography of British Ornithology. By W. H. Mullens, H. Kirke Swann, and Rev. F. C. R. Jourdain. Part iii. Pp. 193–288. (London: Witherby and Co.) 6*s*. net.

Aristotle. By Dr. A. E. Taylor. Revised edition. Pp. 126. (London and Edinburgh: T. C. and E. C. Jack, Ltd.) 1*s*. 3*d*. net.

Wireless Telegraphy and Telephony. By H. M. Dowsett. Pp xxxi+331. (London: The Wireless Press, Ltd.) 9*s*.

Wireless Transmission of Photographs. By M. J. Martin. Second edition. Pp. xv+143. (London: The Wireless Press, Ltd.) 5*s*.

Selected Studies in Elementary Physics. By E. Blake. Pp. viii+176. (London: The Wireless Press, Ltd.) 5*s*.

Volumetric Analysis. By J. B. Coppock. Revised and enlarged edition. Pp. 100. (London: Sir I. Pitman and Sons, Ltd.) 3*s*. 6*d*. net.

A Map of the World (on Mercator's Projection), having Special Reference to Forest Regions and the Geographical Distribution of Timber Trees. Prepared by J. H. Davies. (Edinburgh: W. and A. K. Johnston, Ltd.; London: Macmillan and Co., Ltd.) 8*s*. net.

A Foundation Course in Chemistry. By J. W. Dodgson and J. A. Murray. Second edition. Pp. xii+240+Answers. (London: Hodder and Stoughton, Ltd.) 6*s*. 6*d*. net.

Diary of Societies.

THURSDAY, APRIL 8.

INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates' Section) (at 28 Victoria Street), at 8.—W. D. Pile: The Use of Benzol.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.

FRIDAY, APRIL 9.

ROYAL ASTRONOMICAL SOCIETY, at 5.—E. E. Barnard: Naked-eye Observations of Nova Aquilæ III.—Col. E. H. Hills: The Suspended Zenith Telescope of Durham Observatory, Part I.—Rev. A. L. Cortie: The Great Sun-spot Groups and the Magnetic Storm, 1920 March 22–23.

CONCRETE INSTITUTE, at 6.—T. J. Clark: The Uses of Concrete.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—C. H. Woodfield and Others: Discussion on Cranes: Their Use and Abuse.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—A. H. Howe: The Development and Manufacture of the Thermionic Valve.

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8.15.—(Annual General Meeting), at 8.30.—Mrs. D. Berry and Others: Discussion on Anæsthesia in Operations on the Thyroid Gland.

MONDAY, APRIL 12.

VICTORIA INSTITUTE (at the Central Hall, Westminster), at 4.30.—Rev. Dr. J. F. H. Thomson: The Pentateuch of the Samaritans: When They Got It, and Whence.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—Col. Sir Sidney Burrard: A Brief Review of the Evidence upon which the Theory of Isostasy is Based.

ROYAL INSTITUTION OF GREAT BRITAIN (General Meeting), at 5.

SOCIETY OF ENGINEERS (at Geological Society), at 5.30.—Prof. E. R. Matthews: (1) Flood Prevention Works at Troon, Ayrshire; (2) The Action of Sea Water on Concrete.

SURVEYORS' INSTITUTION (Junior Meeting), at 7.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.

ARISTOTELIAN SOCIETY (at 74 Grosvenor Street), at 8.—J. W. Scott, Dr. G. E. Moore, Prof. H. Wildon Carr, and Prof. G. Dawes Hicks: Symposium on Is the "Concrete Universal" the True Type of Universality?

ROYAL SOCIETY OF ARTS, at 8.—Dr. W. Rosenhain: Aluminium and its Alloys (Cantor Lecture).

SOCIETY OF CHEMICAL INDUSTRY (at Chemical Society), at 8.—Dr. Winifred E. Brenchley and E. H. Richards: The Fertilising Value of Sewage Sludges.—Dr. E. P. Perman: A New Test for Incorporation.—Prof. T. M. Lowry and L. P. McHatton: Experiments on Decrepitation.

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Meeting) (at Institution of Mechanical Engineers), at 8.—Joint Discussion with the Graduates' Association of the Institution of Mechanical Engineers on The Six-hour Working Day and its Effect on Industry.

TUESDAY, APRIL 13.

ROYAL HORTICULTURAL SOCIETY, at 3.—Dr. A. B. Rendle: Plants of Interest in the Day's Exhibition.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Major G. W. C. Kaye: Recent Advances in X-ray Work.

INSTITUTION OF CIVIL ENGINEERS, at 5.30.—Lt.-Col. J. K. Robertson: Richborough Military Transportation Depôt.—Major F. O. Stanford: The War Department Cross-Channel Train-Ferry.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Arthur Willey: An Apodous *Amia calva*.—H. A. Baylis and Dr. Clayton Lane: A Revision of the Nematode Family Gnathostomidæ.—Dr. W. J. Dakin: The Onychophora of Western Australia.—A. M. Altson: The Life-history and Habits of Two Parasites of the Blowfly.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—A. C. Banfield: Prisms.—A. J. Munro: Machinery used in the Manufacture of Photographic Plates.

QUEKETT MICROSCOPICAL CLUB (at 20 Hanover Square), at 7.30.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—A. O. Neville: The Western Australian Aborigines: Their Treatment and Care.

WEDNESDAY, APRIL 14.

ROYAL UNITED SERVICE INSTITUTION, at 3.—Lt.-Col. J. Shakespear: Recent Events on the Assam Frontier.

ROYAL SOCIETY OF ARTS, at 4.30.—J. Thorp: The Fundamental Basis of Good Printing.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at London Day Training College), at 6.—C. A. Claremont: The Functioning of the Will: A Suggested Application of Herrington's Work on Reflexes.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 8.—Capt. P. D. Acland: Trans continental Flying.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Institution of Mechanical Engineers), at 8.—Dr. W. H. Hatfield: The Most Suitable Steels for Automobile Parts.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—A. E. Parkes: The Turbidity Temperature of Fats, Oils, and Fatty Acids, Part I.—Dr. G. W. Monier-Williams: The Interpretation of Milk Records.—Dr. A. F. Joseph and G. A. Freak: The Loss of Free Ammonia from Drinking-Water Samples.—E. Simkinson: A Decanting and Filter-Washing Machine.

THURSDAY, APRIL 15.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—S. Skinner: Ebullition and Evaporation.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Sir George Buchanan: The Ports of India: Their Administration and Development.

LINNEAN SOCIETY, at 5.—Capt. F. Kingdon Ward: Natural History Exploration on the North-east Frontier of Burma.—R. Paulson: Exhibition of Lantern-slides illustrating Definite Stages in the Sporulation and Gonidia within the Thallus of the Lichen *Evernia prunastri*, Ach.

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.

INSTITUTION OF MINING AND METALLURGY (Annual General Meeting) (at Geological Society), at 5.30.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Prof. W. Ripman: Spelling Reform.

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—Dr. C. V. Drysdale: Modern Marine Problems (Kelvin Lecture).

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—J. Weir French: The Unaided Eye, Part III.—R. H. Walls: The Rock Crystal of Brazil.

CHEMICAL SOCIETY, at 8.

FRIDAY, APRIL 16.

CONCRETE INSTITUTE, at 6.—E. Fiander Etchells: Submission of Plans to Local Authorities.

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Meeting) (at Faraday House), at 7.—J. Scott-Taggart: The Vacuum Tube as a Transmitter and Receiver of Continuous Waves.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—J. E. Baty and Others: Discussion on Planing *v.* Milling.

TECHNICAL INSPECTION ASSOCIATION (at Royal Society of Arts), at 7.30.—F. R. Wade: Labour Unrest—Its Causes and Cure.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—Sir Ernest Rutherford: Development of Radiology (Mackenzie Davidson Memorial Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. J. A. McClelland: Ions and Nuclei.

SATURDAY, APRIL 17.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. W. H. Eccles: The Thermionic Vacuum Tube as Detector, Amplifier, and Generator of Electrical Oscillations.

CONTENTS.

	PAGE
The Universities and the Army	157
Woods and Water Supply. By Dr. Hugh Robert Mill	158
The Wilds of South America	159
Life and Temperature	161
A University Course in Botany	162
Recent Mathematical Text-books. By J. M.	162
Our Bookshelf	163
Letters to the Editor:—	
Knowledge and Power.—"F.O.I."; Dr. John W. Evans, F.R.S.	165
The Secondary Spectrum of Hydrogen.—Prof. J. W. Nicholson, F.R.S.	166
International Council for Fishery Investigations.—Prof. W. C. McIntosh, F.R.S.	167
The Plumage Bill and Bird Protection.—Sir H. H. Johnston, G.C.M.G., K.C.B.; Prof. H. M. Lefroy; Right Hon. Sir Herbert Maxwell, Bart., F.R.S.; Prof. Arthur Dendy, F.R.S.	168
The Magnetic Storm of March 22–23 and Associated Phenomena.—Dr. A. Crichton Mitchell	170
Science and the New Army.—Prof. A. R. Richardson	170
An Electronic Theory of Isomerism.—W. E. Garner; S. C. Bradford	171
Percussion-Figures.—Dr. B. G. Escher	171
A Peculiar Halo. (*With Diagram.*)—Capt. C. J. P. Cave	171
Sea-birds: Their Relation to the Fisheries and Agriculture. (*With Diagram.*) By Dr. Walter E. Collinge	172
The Imperial College of Science and Technology	173
Magnetic Disturbances and Geological Structure	175
British Crop Production. By Dr. Edward J. Russell, F.R.S.	176
Notes	178
Our Astronomical Column:—	
Capella	183
Cape Observations of the Sun, Mercury, and Venus	183
Basic Slag and its Uses in Agriculture	183
Verification of Screw Gauges for Munitions of War	184
The Composition of Salvarsan	185
University and Educational Intelligence	185
Societies and Academies	186
Books Received	187
Diary of Societies	188

Editorial and Publishing Offices:
MACMILLAN AND CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Advertisements and business letters to be addressed to the Publishers.

Editorial Communications to the Editor.
Telegraphic Address: PHUSIS, LONDON.
Telephone Number: GERRARD 8830.